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SCICOM STEERING GROUP ON ECOSYSTEM PROCESSES AND DYNAMICS

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Report of the ICES – IOC Working Group on Harmful Algal Bloom Dynamics (WGHABD)

28 April – 2 May 2014

Haarlem, the Netherlands



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International Council for
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Executive summary

The ICES-IOC Working Group on Harmful Algal Bloom Dynamics (WGHABD), chaired by Bengt Karlson, Sweden, met in Haarlem, the Netherlands 28 April to 2 May 2014. Fifteen scientists from ten countries attended. This includes a participant representing the IOC. Previously WGHABD reported results and activities yearly. This report is the first three year report; it includes national HAB-reports for the period 2011 to 2013. WGHABD is in the process of adapting to the novel three year ICES reporting format.

- WGHABD have terms of references from and report to both to Scientific Committee, SCICOM, ICES, through the Scientific Steering Group on Ecosystem Processes and Dynamics, SSGEPD and the Intergovernmental Panel on Harmful Algal Blooms, Intergovernmental Oceanographic Commission of the UNESCO.
- Format of work:
 - Yearly meetings and work in between meetings. On occasion special workshops are arranged.
 - Collect data on HAB and effects of HAB crossing national borders
 - HAB-organisms
 - Effects of HABs, e.g. toxins in shellfish
 - Dynamics of bloom development
 - Modelling and physical oceanography
 - Auto ecology of HAB organisms
 - Biological interactions
 - Influence of riverine inputs etc.
 - New findings, e.g. special HAB event, novel methods
- HABs remain a serious problem for the aquaculture industry in most ICES countries. Algal toxins accumulating in shellfish is one concern and direct effects on fish in farms is another.
- HAB species and HAB events are observed in new geographic areas. This is likely to be an effect of changed environmental conditions, e.g. warming. Also the spreading of organisms through ballast water etc. may contribute.
- Benthic harmful algal blooms include benthic dinoflagellates causing ciguatera have been observed e.g. in the Azores, Canary Islands and in Madeira.
- Algal toxins in aerosols on beaches may cause breathing problems.
- Cyanobacteria blooms in the Baltic Sea remain a problem.
- WGHABD will contribute to a Global Harmful Algal Bloom Status Report which the UNESCO-IOC Intergovernmental Panel on Harmful Algal Blooms is to produce. It is an opportunity for further collaboration ICES-IOC.
- Examples of time series data on harmful algae and algal toxins were presented. Datasets were based on the Harmful Algal Event database <http://haedat.iode.org>
- The HAB session at the 2014 ICES ASC in La Coruna was presented.

- The plans for a scientific symposium on Climate change and Harmful Algal Blooms in 2015 in Gothenburg, Sweden, was discussed.
- New findings were reported. One example is a bloom *Dinophysis*, producing diarrhetic shellfish toxins, at the Shetland Islands. Here the effects of physical transport were evident. A conclusion is that there is a need to combine high frequency observations of HAB-species with modelling to be able to predict bloom events.
- A session on Automated Harmful Algal Bloom in situ observations Systems was held in 2013. A conclusion is that *in situ* Imaging Flow Cytometry is now a viable tool for studying HAB-dynamics and for monitoring of some HAB organisms. Three different instruments are available commercially. Automated sampling and automated analysis of phytoplankton composition and abundance twice an hour is feasible.
- A review of fish killing algae is in production.
- Draft terms of references for the period 2015–2017 were produced.

The WGHABD plan to meet in Lisbon, Portugal, 13–17 April 2015.

1 Opening of the meeting

The chair Bengt Karlson, opened the meeting that was arranged in Haarlem, the Netherlands. The local host, Marnix Poelman, welcomed the participants. Altogether fifteen participants from ten countries participated. In addition Harry Koos, an invited guest from the Dutch company CytoSense participated during the session on automated in situ observation systems.

2 Adoption of the agenda

The agenda was adopted.

3 Terms of reference A – New findings

Report on new findings in the area of harmful algal bloom dynamics

3.1 Diarrhetic shellfish poisoning incident in the UK, summer 2013

Presented by Keith Davidson

During July 2013 approximately 70 people in south east England reported symptoms consistent with diarrhetic shellfish poisoning. The vast majority of cases occurred between 13 and 15 July.

The cases were linked to the consumption of mussels originating from a particular harvesting area in the Shetland Isles Scotland.

After these mussels were harvested, an unusually high toxin level was detected by the regulatory weekly monitoring programme.

The negative publicity for the shellfish industry from this event was significant, with news reports on the BBC and other outlets reducing consumer confidence.

The biotoxin event was linked to an exceptionally rapid increase in the abundance of *Dinophysis* sp. in west coast Shetland waters, with cell abundances reaching ~ 8000 cells L⁻¹ at some sites with associated high shellfish toxicity. The speed of increase in cell numbers was such that toxicity increased from sub threshold to high levels (~1500 ug/kg) in a time scale less than the 1 week resolution of regulatory sampling.

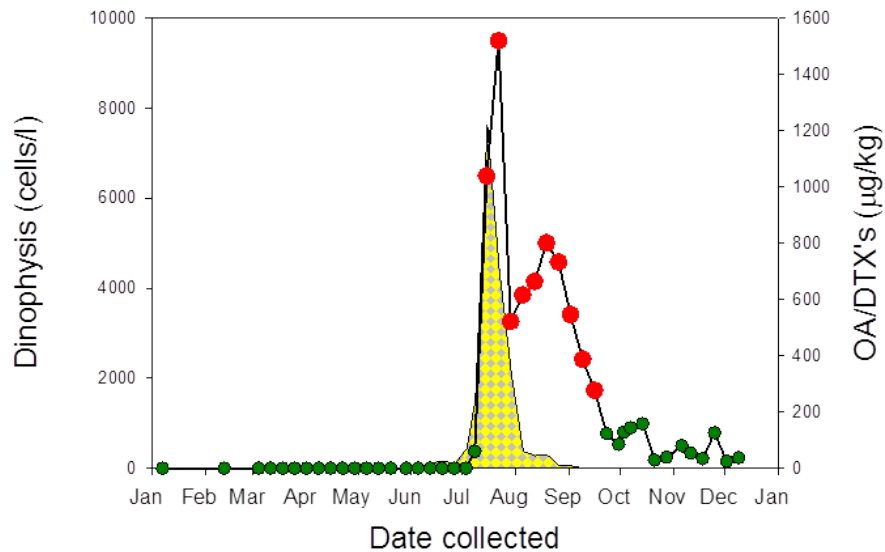


Figure 1: *Dinophysis* abundance and shellfish toxicity at the Seggi Bight site from which the affected mussels were harvested. Yellow hatching: *Dinophysis*, Circles: shellfish toxicity, green – below regulatory threshold, red above regulatory threshold.

Subsequent to the event the industry expressed a desire for methods of providing early warning of exceptional blooms to minimise the likelihood of supplying contaminated product to market.

As a result the abundance of *Dinophysis* in the Shetland Isles over the period of high frequency regulatory monitoring (2006–13) was analysed in relation to potential environmental drivers of the bloom.

Using a chi squared test it was demonstrated that statistically significantly higher *Dinophysis* abundance on the west coast off Shetland occurred during 2013 and 2006.

Analysis of wind direction indicated that the prevailing wind in the region is SE. However, in both 2013 and 2006, during the months of high *Dinophysis* abundance (June–August) winds blew primarily from the SW.

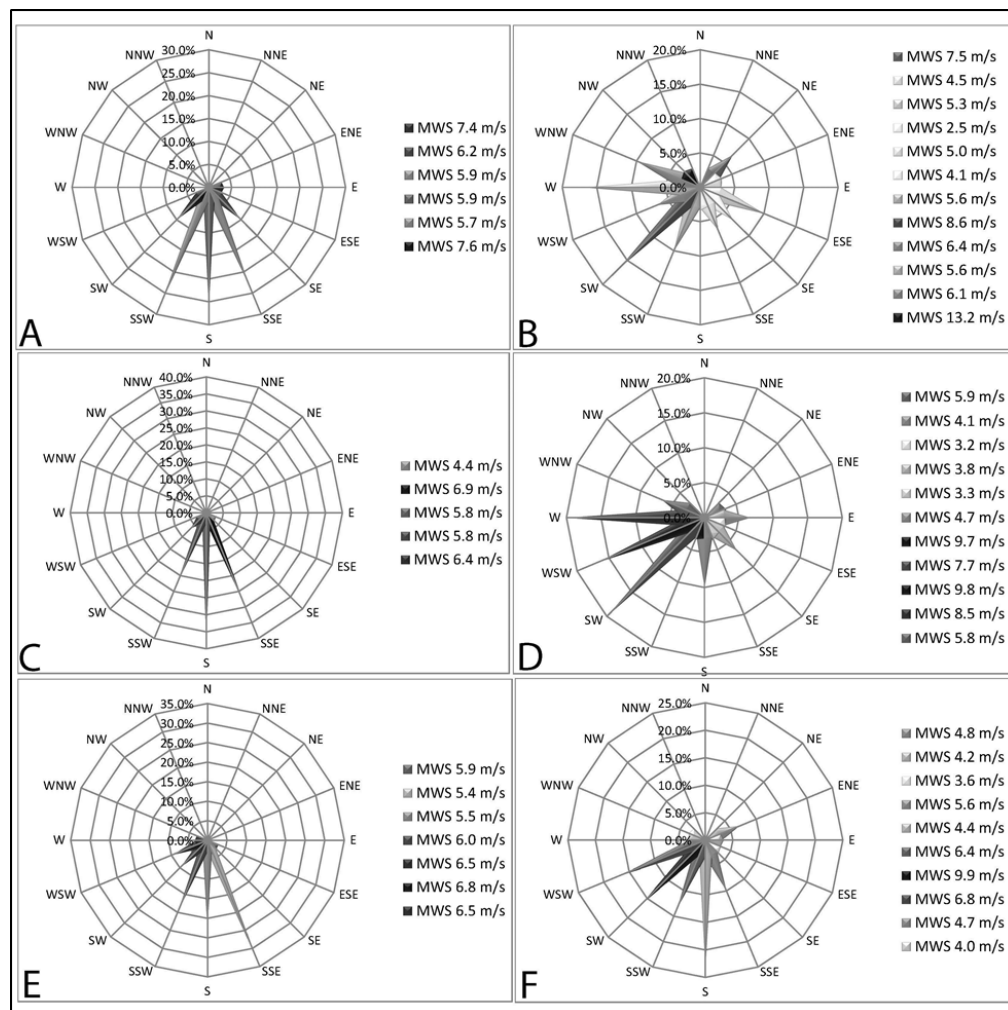


Figure 2: Wind rose for 2006–12 A, C, E and 2013 B,C,D for June (top), July (middle), August (Bottom)

We therefore hypothesise that the rapid increase in *Dinophysis* was due to wind driven advection of offshore *Dinophysis* to the fjords of the west coast of Shetland where shellfish aquaculture is sited. This is consistent with the aquaculture sites on the east coast not experiencing the rapid increases seen in the west.

Analysis of expected in situ growth rates, based on literature estimates of maximum *Dinophysis* growth rates, indicated that in situ growth was incapable of generating the observed increase in *Dinophysis* further strengthening the advection hypothesis.

Weekly bulletins of harmful algal risk are being generated in the Shetland Isles now incorporating wind roses to assess wind advected *Dinophysis* risk.

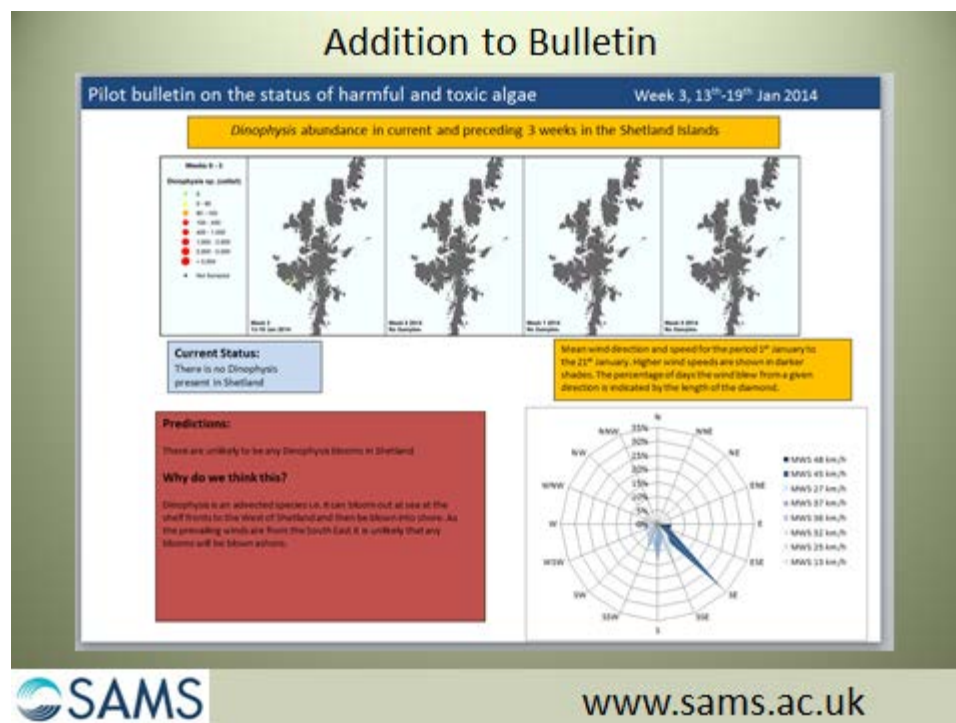


Figure 3: example weekly bulletin outlining risk of wind advected *Dinophysis*.

3.2 The first association of domoic acid production with *Pseudo-nitzschia pseudodelicatissima* –complex in Scottish waters

Eileen Bresnan, Jean-Pierre Lacaze and Kathryn Cook, Marine Scotland Science

Marine Scotland Science operate a coastal ecosystem monitoring programme 5 km off-shore from the village of Stonehaven in the North East of Scotland (56° 57.8' N, 02 ° 06.2' W). Temperature, salinity, nutrients, phytoplankton and zooplankton have been sampled at this site since 1997 on a weekly basis (weather permitting). Data from this site is being used to fulfil the monitoring requirements of the Water Framework Directive and Marine Strategy Framework Directive. From June to Sept 2008, copepods sampled at this site were analysed for the presence of algal toxins. Domoic acid was recorded in copepods collected on 20 different sampling occasions between June and October. Concentrations ranged from 1–19 µg domoic acid per copepod. The highest concentration (19 µg domoic acid per copepod) was associated with a bloom of *P. delicatissima* type cells as identified using light microscopy (diameter < 3µm). This bloom reached a maximum cell density of 130 000 cells L⁻¹. Analysis using transmission electron microscopy (TEM) revealed that the morphology of the *Pseudo-nitzschia* cells in this bloom were similar to an undescribed species of *Pseudo-nitzschia* within the *Pseudo-nitzschia pseudodelicatissima* complex reported from the Bay of Fundy (*P. pseudodelicatissima* BOF, Kaczmarek *et al.*, 2005), the Gulf of Maine (*P. sp.* GOM, Fernandes *et al.*, 2014), the Spanish Atlantic coast (*P. sp.* Ner-D6, Orive *et al.*, 2010) and Australia (*P. sp.* Hobart5, Lundholm *et al.*, 2003). Morphometrics recorded from the Scottish cells include length (68µm), width (1.2–1.5µm), Central Inter-

space (yes), fibulae in 10µm (23–25), striae in 10µm 23–25, rows of poroids (1) and poroids in 1µm (5–6). Blooms of *Pseudo-nitzschia* similar to this species have been observed previously in Scottish waters in the weeks following a *Karenia mikimotoi* bloom in 2006. This is the first association of domoic acid with a *P. delicatissima* type cell (as identified using light microscopy) in Scottish waters.

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- Orive E., Laza-Martinez A., Seone S., Alonso A., Andrade R. and Miguel I. (2010). Diversity of *Pseudo-nitzschia* in the southeastern Bay of Biscay. *Diatom Res.*, 25, 125 – 145.

3.3 A Degree-Day approach to understanding *Alexandrium fundyense* bloom dynamics

Don Anderson, USA

Don Anderson provided a summary of a paper that is now in press in *Limnology and Oceanography* by D. Ralston *et al.* (Temperature dependence of an estuarine harmful algal bloom: Resolving interannual variability in bloom dynamics using a degree day approach). Briefly, field surveys have been carried out in the Nauset Estuary System (NES) on Cape Cod, Ma (USA) where localized blooms occur annually in three kettle holes or salt ponds at the distal ends of the estuary. These blooms are isolated from each other, and from the central marsh system and offshore waters, so each functions as a self-seeding, localized habitat.

The survey data from 2009, 2010, 2011, and 2012 show considerable interannual variability in bloom timing within each individual salt pond, as well as between salt ponds in the same year. Figure 1 shows the data for cell abundance for these years and locations. The bloom timing varied among the salt ponds and among years, although the blooms had similar durations and maximum cell concentrations. Nutrient concentrations did not correlate with the growth of the bloom, but differences in water temperature among years and ponds were significant. Net growth rates inferred from the surveys were similar to those from laboratory experiments, and increased linearly with temperature. A growing degree day calculation was used to account for effects of interannual variability and spatial gradients in water temperature on population development.

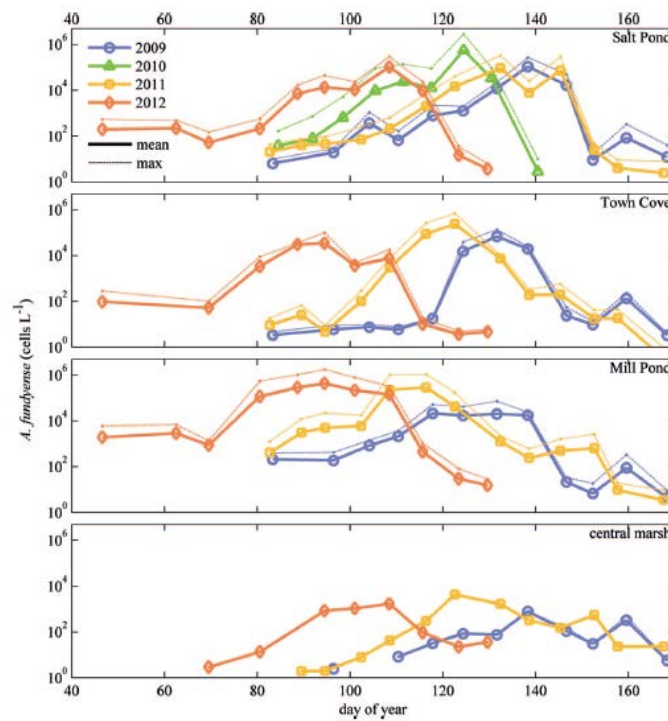


Figure 1. Data on maximum and mean *Alexandrium fundyense* cell abundance for three salt ponds within the Nauset Estuary System for 2009, 2010, 2011, and 2012. From Ralston *et al.*, (in press).

Growing degree days have been used extensively to predict development phases of terrestrial plants and insects, and more recently have been applied to zooplankton and fisheries. Degree days (DD) are calculated as the integral over time (t) of temperature above a threshold value:

$$DD(t) = \sum_{i=t_0}^t (T_i - T_{\text{base}}) \Delta t$$

where T is the water temperature, T_{base} is a lower physiological limit below which growth does not occur (set at 0 °C for *Alexandrium*), and t_0 is the starting time for the growth phase.

When the *Alexandrium* data from each year and each salt pond are plotted versus degree day rather than calendar day, the curves at each location collapse onto a single pattern, and much of the interannual variability in the timing of the *Alexandrium* blooms disappears, suggesting a common mechanism underlining each bloom (Figure 2). Degree days account for the change in the population due both to the duration of the bloom and rate of growth, as a direct comparison of cell concentration vs. temperature alone does not explain the interannual variation. Environmental factors such as nutrients and salinity were not significantly correlated with cell abundance over multiple years individually or in a stepwise linear regression. Placing the cell concentrations in degree day space collapsed variability in the timing of bloom onset, development, and termination across

years and between ponds, suggesting that this relatively simple metric could be used as an early-warning indicator for HABs in Nauset and similar areas with localized, self-seeding blooms. For example, the onset of the first toxicity in shellfish occurred in all three salt ponds around DD 500, so one could predict when sampling might commence in a given year by tabulating degree days. In warm winters, sampling might need to start as much as a year earlier (as in 2012) than in colder years.

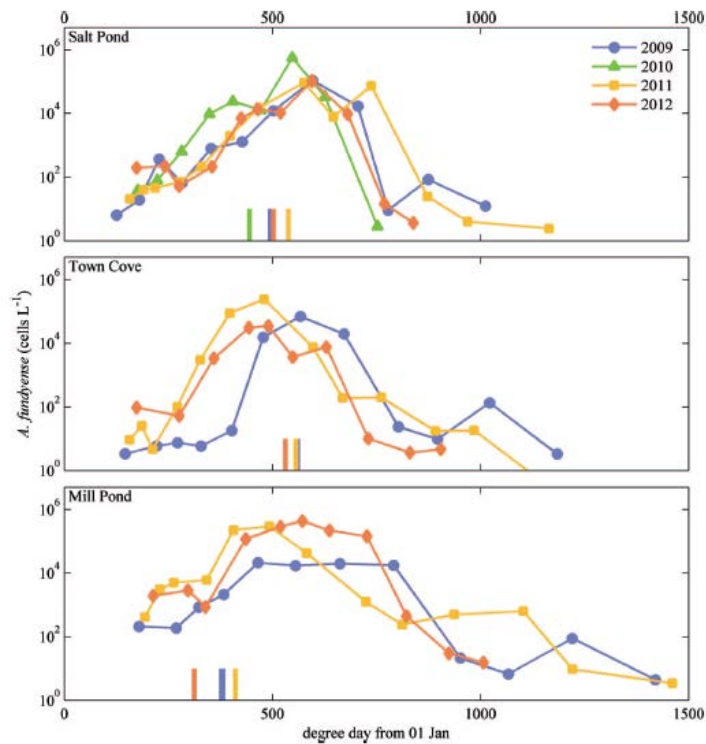


Figure 2. Data from Figure 1 plotted versus degree days for each location and year. Vertical lines show the timing of the first detection of toxicity in shellfish at that location.

3.4 A study of cyanobacteria blooms in the Baltic Sea using novel methods

Bengt Karlson, Yue Hu and Anders Andersson

Introduction

In July 2013 the Swedish Meteorological and Hydrological Institute and the KTH Royal Institute of Technology carried out a joint study of phytoplankton, including harmful algae, in the Baltic Sea area. The study's main focus was harmful cyanobacteria. The study was part of the EU FP7 project JERICO - Towards a joint European research infrastructure network for coastal observatories <http://jerico-fp7.eu/> . A FerryBox system on the merchant vessel TransPaper was used for automated measurements and for collection of water samples. In addition satellite remote sensing data from NASA Aqua MODIS was used. Parameters measured include:

Water Samples

- Phytoplankton abundance, biodiversity and biomass (Utermöhl method)
- Plankton diversity - High Throughput Sequencing of 16S and 18S rDNA (bar-coding)
- Photosynthetic pigments, HPLC-analysis including chlorophyll a

Underway data

Collected every 20 seconds which corresponding to approximately 200 m depending on ship speed.

- Salinity
- Temperature
- Chlorophyll fluorescence
- Phycocyanin fluorescence
- Oxygen
- Turbidity
- Fluorescence from Coloured Dissolved Organic Matter (CDOM)
- Photosynthetic Active Radiation
- Automated photography of surface accumulations of cyanobacteria

Remote sensing

- Surface accumulations of cyanobacteria (algorithm described by Kahru and Elmgren 2014)

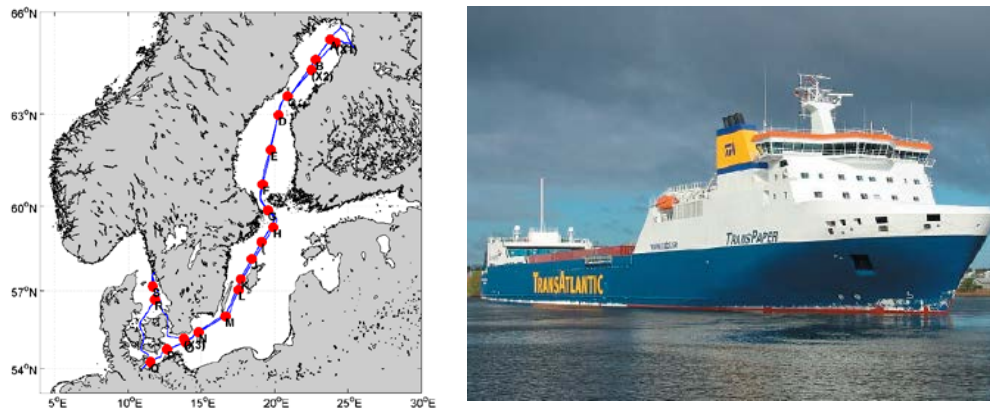


Figure1. Sampling locations and ship.

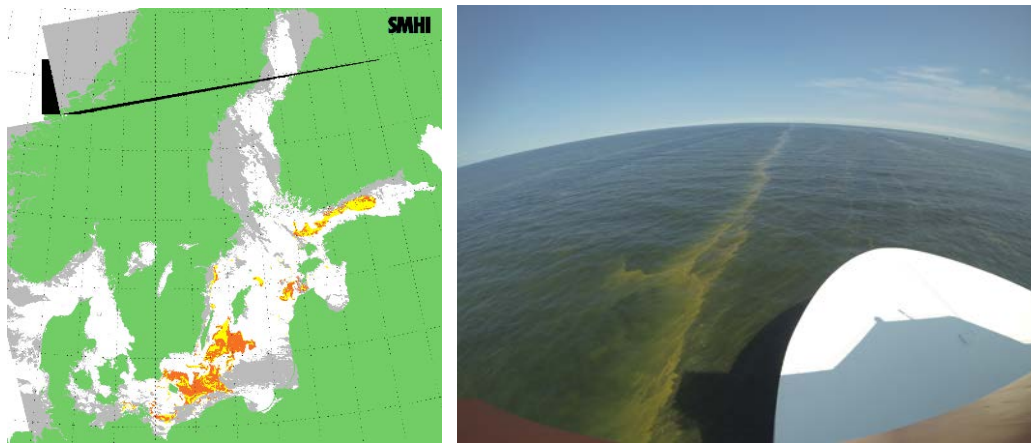


Figure 2. Left: Surface accumulations of cyanobacteria 17 July 2013 observed using satellite remote sensing. From the Baltic Algae Watch System. www.smhi.se. Right: Surface accumulations of cyanobacteria from automated photography. The bow of the ship is also visible.

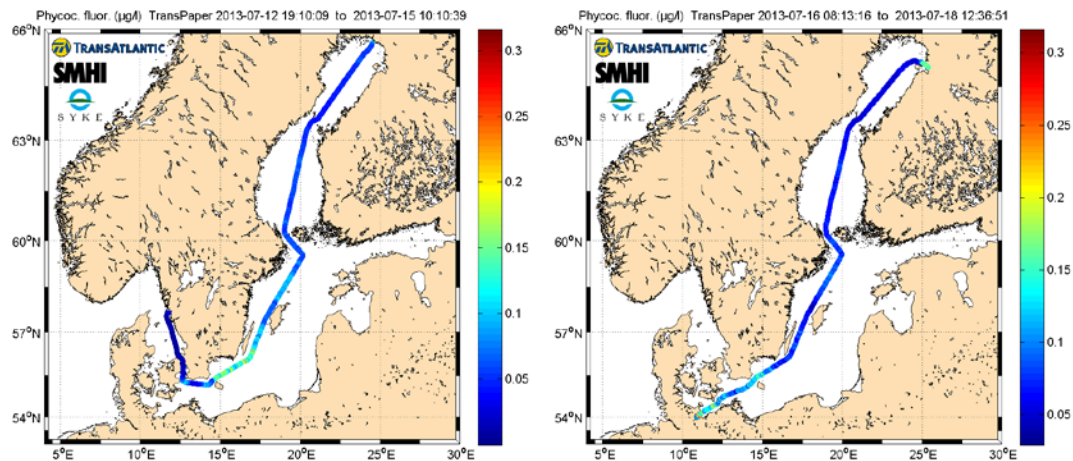


Figure 3. Phycocyanin fluorescence along the route of the ship. Left: the leg between Gothenburg and Kemi, right: the leg between Oulu and Lübeck.

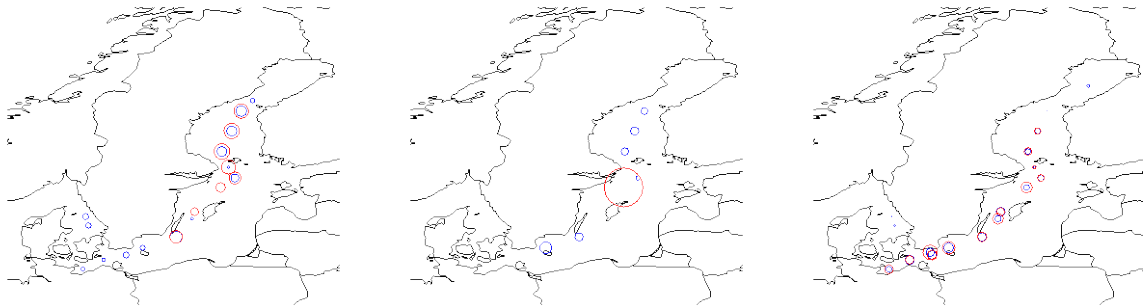


Figure 4. Comparison of rDNA relative counts and microscope counts: Left *Dinophysis* - middle *Alexandrium* and right: *Nodularia*, preliminary data. Blue circles – rDNA barcoding (relative number of sequences of respective OTUs, red circles – cell abundance based on microscopy.

Phycocyanin fluorescence is a proxy for the biomass of phycocyanin containing cyanobacteria. These include the genera *Nodularia*, *Aphanizomenon* and *Dolichospermum* that are nitrogen fixers. *Nodularia spumigena* is toxic in the Baltic Sea. The data on phycocyanin fluorescence show high biomass in the area between Lübeck, Bornholm and the island of Öland. This is consistent with satellite observations. High phycocyanin fluorescence was also recorded north of Gotland where no surface accumulations of cyanobacteria were detected using satellite remote sensing. The results from this multi-method study indicate that satellite remote sensing of cyanobacteria surface accumulations also show a different view of the distribution of cyanobacteria compared to analysis of water samples. Both the microscope-based data and the rDNA-data from water samples show a wider distribution of cyanobacteria compared to the data from satellite remote sensing. The data from automated photography of the cyanobacteria at the sea surface is only useful during daytime. This data set with photos of the sea surface every minute has not yet been worked up.

The data on the distribution of HAB-species from microscopy and rDNA barcoding show similar patterns for *Dinophysis* and *Nodularia*. However, for *Alexandrium* the rDNA data show a much wider distribution of the genus compared to data based on microscopy. It should be noted that a larger volume of water was analysed for rDNA (200–500 mL) compared to volume used for the microscope analysis (20 mL).

3.5 DYMAPHY

Rafael Siano

The EU Intereg project Development of a DYnamic observation system for the assessment of MARine water quality, based on PHYtoplankton analysis (2010–2014) was presented.

3.6 PHYCOTOX

Rafael Siano

The French network “PHYCOTOX”, *from microalgae to the risks for humans and ecosystem: a French working network on Harmful Algal Blooms* was presented.

4 Terms of reference B – National reports

Deliver National Reports on harmful algal events and bloom dynamics for the year 2013

4.1 A note about national reports

This document includes three year national reports for years 2011–2013 for Canada, France, Germany, the Netherlands, Poland, Portugal, Spain, Sweden, United Kingdom and the United States of America. In the WGHABD-reports from 2012 and 2013 additional information for years 2011 and 2012 is available, e.g. for Ireland, Denmark, Norway and Finland.

4.2 Canada National Report 2011–2013

Jennifer Martin

Canada Country Report (2011)

West Coast:

PSP

2011 was considered to be a “normal” year with shellfish closures as a result of elevated levels of PSP toxins. The highest level observed was 1334 µg/100 g STX equiv. on June 6 in *Mytilus edulis* in the lower Strait of Georgia with shellfish harvesting areas closed to harvesting from May 6–Oct. 24.

DSP

The first documented occurrence of Diarrhetic Shellfish Poisoning occurred in British Columbia in 2011. Sixty people became ill following consumption of mussels collected July 19–Aug 2 from Gorge Harbour, Cortes Island. A phytoplankton monitoring programme collecting samples for the salmonid aquaculture industry collected samples approximately 25 km away from the affected shellfish site and detected 24,000 *Dinophysis* spp. cells•L⁻¹. *Dinophysis acuminata* were the most abundant (82%), *D. acuta* (9%) and *D. fortii* (4%), and *D. rotundata* (5%)¹.

¹Esenkulova, S. and N. Haigh. 2012. First Report of *Dinophysis* species causing Diarrhetic Shellfish Poisoning in British Columbia, Canada. Harmful Algal News. 45:12, pp 16–17.

ASP

No shellfish areas were closed due to unacceptable levels of DA in 2011.

Salmon mortalities in fish culture operations.

Heterosigma akashiwo was responsible for salmon mortalities in the Upper Strait of Georgia, British Columbia on June 23 when concentrations were 400 000 cells•L⁻¹. In Clayoquot Sound, Vancouver Island, *H. akashiwo* was observed at levels of 300 000 cells•L⁻¹ on Sept. 12 resulting in further mortalities. Interestingly, at a salmon farm at Jervis Island, Lower Strait of Georgia, concentrations of 22 million cells•L⁻¹ were observed with no ill effects to the farmed salmon.

East Coast

PSP

2011 would be considered to be a “normal” year with the regular periodic closures of shellfish harvesting areas due to unsafe levels of PSP toxins on the east coast. Highest concentrations of *Alexandrium fundyense* observed in the Bay of Fundy, southwest New Brunswick, were 103,400 cells•L⁻¹ and highest shellfish toxicity (3640 µg 100g STX equiv.) was detected in *Mytilus edulis* at Bocabec Bay. Although shellfish toxicity values only reached 849 µg 100g STX equiv. at Deadmans Harbour, the shellfish beds were closed throughout the year due to unacceptable levels of PSP toxins with low levels detected through the winter.

Mytilus edulis from the Atlantic coast of Nova Scotia (Mahone Bay) toxicity values reached levels of 1501 µg 100g STX equiv. and that area was closed from June 10–July 13.

No report was received from the St. Lawrence Estuary but shellfish harvesting areas were above threshold levels and closed to harvesting for a portion of the spring/summer.

Newfoundland and the Gulf of St. Lawrence did not experience any shellfish closures in 2011.

DSP

No shellfish harvesting areas were closed due to unacceptable levels of DSP toxins in shellfish in 2011.

ASP

No shellfish harvesting areas were closed due to unacceptable levels of DA in shellfish in 2011.

Salmon Mortalities

There were no salmon mortalities at aquaculture operations on the east coast associated with HABs in 2011.

Canada Country Report (2012)

West Coast:

Canada's west coast

PSP

Shellfish harvesting closures as a result of unacceptable levels of PSP toxins are recurring, annual events along Canada's west coast. During 2012, the highest PSP shellfish toxicity (5200 μg STX equiv. 100g) was detected at Effingham Inlet (British Columbia) in blue mussels (*Mytilus edulis*) on July 17.

ASP

Domoic acid above the regulatory level (41.68 $\mu\text{g/g}$) was measured in razor clams (*Siliqua patula*) in mid-September at Graham Island.

DSP

Okadaic acid and DTX-1 (0.2 $\mu\text{g/g}$) were detected in blue mussels (*M. edulis*) at Effingham Island in mid-September resulting in shellfish areas being closed to harvesting.

Salmon mortalities in fish culture operations:

Heterosigma akashiwo was responsible for salmon mortalities in Nanaimo Harbour on July 19 when concentrations were 30 million cells $\bullet\text{L}^{-1}$. *H. akashiwo* was also implicated in salmon mortalities on July 27 when concentrations reached 3 million cells $\bullet\text{L}^{-1}$ in Clayoquot Sound and on Aug. 14 in Quatsino Sound with 400 000 cells $\bullet\text{L}^{-1}$. On Aug. 25 and Sept. 11, fish farms in Mathieson Channel and Nootka Sound were affected when *Chatonella* cf. *marina* populations reached 100 000 and 70 000 cells $\bullet\text{L}^{-1}$, respectively. *Chaetoceros convolutes* caused kills in the Sechart Inlet from Apr 26–June 21 with maximum detected cell concentrations of 65 000 cells $\bullet\text{L}^{-1}$ detected. In addition, *Pseudopedinella pyri-formis* was implicated (for the first time in British Columbia) when salmon mortalities occurred in late May when 3 million cells $\bullet\text{L}^{-1}$ were observed.

East Coast

PSP

2012 would be considered to be a “lower than normal” year with the regular periodic closures of shellfish harvesting areas due to unsafe levels of PSP toxins on the east coast. Highest concentrations of *Alexandrium fundyense* observed in the Bay of Fundy, south-west New Brunswick, were 15,780 cells•L⁻¹ and highest shellfish toxicity detected in *Mya arenaria* was 715 µg 100 g STX equiv.

The Atlantic coast of Nova Scotia toxicity values did not exceed 80 µg 100g STX equiv. and no shellfish beds were closed to harvesting.

No report was received from the St. Lawrence Estuary but shellfish harvesting areas were above threshold levels and closed to harvesting for a portion of the spring/summer.

Newfoundland and the Gulf of St. Lawrence did not experience any shellfish closures in 2012.

DSP

No shellfish harvesting areas were closed due to unacceptable levels of DSP toxins in shellfish in 2012.

ASP

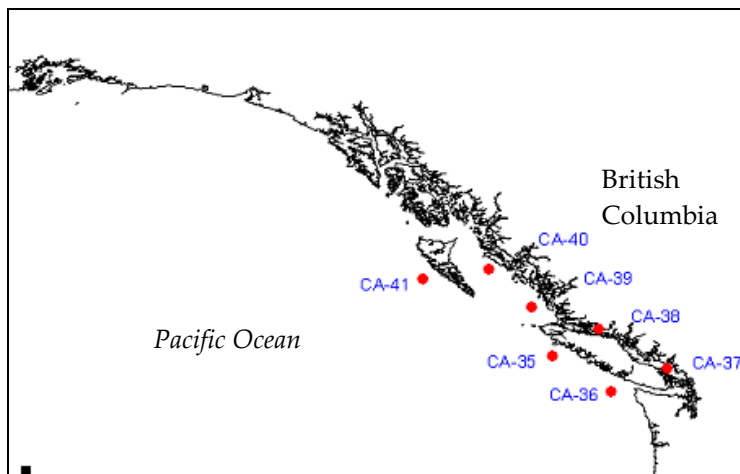
No shellfish harvesting areas were closed due to unacceptable levels of DA in shellfish in 2012.

Salmon Mortalities

There were no salmon mortalities at aquaculture operations on the east coast associated with HABs in 2012.

Canada (2013)

Pacific Coast (British Columbia)



Marine toxins:

PSP

There were shellfish closures from Aug. 13 to Nov. 12 in Sproat Bay (HAE-DAT area CA-36) when shellfish toxicity values in *Mytilus californianus* exceeded the regulatory limit – the highest value measured by LC-MS was 5000 µg STX equiv. 100 g meat. Closures also occurred in Nuchatlitz (area CA-35) from Aug 14 to Oct. 29 with highest levels of 630 µg STX equiv. 100 g meat (*Mytilus californianus*). In Patricia Bay (CA-37) PSP values reached 1600 µg STX equiv. 100 g meat (*Mytilus californianus*) and the area was closed from June 24 through July 30. Closures also occurred from May 16 June 17 and Aug. 19 to Sept. 19 in Okeover Inlet (CA-38) when PSP values reached 380 µg STX equiv. 100 g meat; from Oct. 9 to Oct. 28 at Ardmillan Passage (CA-39) with the highest value of 390; Evinrude Bay (CA-40) from Oct. 16-Nov. 13 with the highest value of 230; and Graham Island (CA-41) in mid-May with 430 µg STX equiv. 100 g meat. The shellfish with the greatest toxicity value was *Mytilus californianus* in all cases.

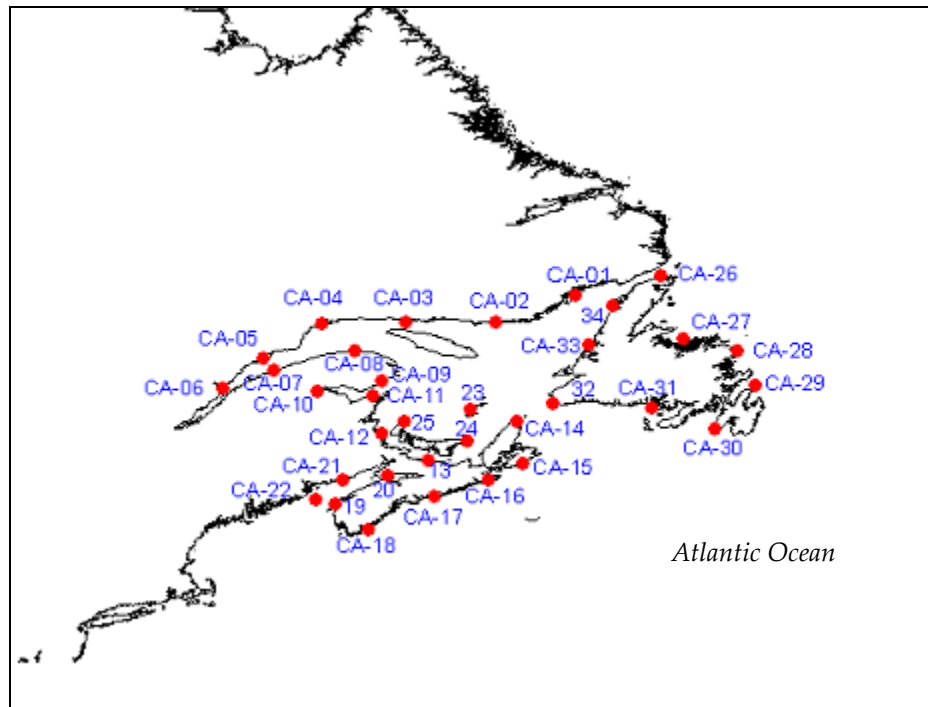
DSP

Closures occurred in three regions (CA-35, 36 and 39) as a result of unsafe levels of DSP toxins. Shellfish from the west coast of Vancouver Island (CA-35) had 0.37 µg g in *Mytilus californianus* - this area was already closed for an extended period. Areas on the lower west coast of Vancouver Island (CA-36) at Effingham Inlet were closed to harvesting from May 21 to May 28 with levels of 0.42 µg g. The central coast of British Columbia (CA-39) was closed from Oct. 15 to Nov. 18 due to unsafe levels of DSP toxins (0.52 µg g).

Fish Kills (Atlantic salmon, *Salmo salar*)

Mortalities occurred at the following 3 aquaculture sites: Quasino Sound (CA-25) on Sept. 28 when 14 million *Pseudochattonella* cf. *verruculosa* cells L⁻¹ were observed; Jervis Inlet (CA-37) on July 19 with 5 million *Herosigma akashiwo* cells L⁻¹; and Calm Channel (CA-38) on June 26 with 2.6 million *Heterosigma akashiwo* cells L⁻¹.

Atlantic Coast



PSP

The following areas in Quebec were closed to shellfish harvesting: CA-04 with the highest value detected at Pointes-aux-Anglais on July 7 (331 µg STX equiv. 100 g *Mya arenaria*); CA-05 - highest value at Pointes-aux-Outardes on June 15 (739 µg STX equiv. 100 g *Mytilus edulis*); CA-08 - highest value on June 27 at Capucins (8550 µg STX equiv. 100 g *Mytilus edulis*); and CA-09 where the highest value measured was 4885 µg STX equiv. 100 g *Mytilus edulis* at Baie du Grand Pabo on June 18.

Areas closed in Nova Scotia included: CA-17 with the highest value detected at Sambro (681 µg STX equiv. 100 g *Mya arenaria*) on June 27; and CA-18 where the highest value measured was 363 µg STX equiv. 100 g *Mytilus edulis*) on June 3.

The Bay of Fundy, New Brunswick area CA-22 had closures due to PSP with the highest value (407 µg STX equiv. 100 g *Mya arenaria*) observed at Deadmans Harbour on June 5.

ASP

Area CA-01 experienced closures of shellfish harvesting areas due to unsafe levels of domoic acid from July 28 to Aug. 8 with highest values (48 µg g) detected on July 28 at

Havre des Belles Amours. Area CA-16 also experienced closures with the greatest value detected (20 µg g) at Shelburne Harbour on July 10. The closure was from July 10–July 12. Domoic acid was also detected in scallop gonad samples (420 µg g) from Area CA-23 at the Magdalen Islands with highest levels reached at Ile d'Entree au large.

4.3 Denmark National Report 2013

Per Andersen (presented by Henrik Enevoldsen)

Harmful Algal Blooms in Denmark in 2013 in brief

- No harmful marine events in 2013.
- *Pseudochattonella* spp. was observed in the spring in the southern part of the Kattegat but in rather low concentrations (<10.000 cells/l). No harmful effects on fish in marine aquaculture and no delay in the release of fish (rainbow trout) into marine fish farms.
- Increased mortality of trout and Koi carps in freshwater aquaculture systems related to blooms of small naked or thin-walled dinoflagellates (*Tyrannodinium* etc) >500.000 cells/l) and *Ochromonas* reported to produce toxins belonging to the Chlorosulfo-lipids (CSL) respectively.
- HAB species (*Dinophysis* spp., *Alexandrium* spp. and *Pseudonitzschia* spp.) potentially causing accumulation of algal toxins in shellfish were observed in concentrations below action limits. *Azadinium* not observed!
- No observations of DSP, ASP or PSP above the regulatory limits.

4.4 France National Report 2011–2013

Catherine Beline and Raffael Siano

Region: French Channel and Atlantic coast

Dinophysis and lipophilic (DSP) toxins

Dinophysis was observed every year during the 2011–2013 period, on a large part of the French coast, especially in Southern Brittany, and along the whole Atlantic coast. It was observed less frequently along the Northern coast of France and in Northern Brittany. Species were generally identified as genus *Dinophysis* or *D. acuminata*, sometimes as *D. caudata*, *fortii*, *sacculus* or *tripos*. The annual maxima were most of the time below 10 000 cells/L. The national maximum was often observed at North of Seine bay (Channel). The first developments of *Dinophysis* were generally observed in March–April in Atlantic, in July–August in Channel. *Dinophysis* was rarely observed in winter.

Many DSP toxic episodes were observed every year. They were always associated to the group of toxins OA+DTXs+PTXs (Okadaic Acid + Dinophysistoxins + Pectenotoxins), never to the group of Azaspiracids (which were very rarely observed), nor to the group of Yessotoxins (which were observed on several sampling sites, but always at very low concentrations). These toxic episodes, defined from results above the official sanitary threshold (which is 160 µg/kg of equ.OA according to the European Directives), are described per year below (see Fig. 1 for an illustration for 2011 and 2012).

2011 - The zones concerned by DSP toxic episodes were numerous along the Atlantic coast, but much less numerous along the Channel coast. Affected shellfish were various : mussels, oysters, donax, cockles, clams, etc. The maxima toxin concentrations were observed in mussels (*Mytilus*) of Brest bay, with 4130 µg/kg, and in *Donax* of Douarnenez bay, with 3050 µg/kg.

2012 - The geographic distribution of toxic episodes was similar to 2011. The maxima toxin concentration were very high, they were observed in Arcachon bay (Southern part of the French Atlantic coast) with 37 300 µg/kg in mussels (*Mytilus*) and 11 750 µg/kg in oysters (*Crassostrea gigas*).

2013 - The distribution of toxic episodes was rather different from that of the two previous years. In several zones of Channel around Seine bay, scallops were particularly affected. In Atlantic, only the Southern part of Brittany was concerned. The maxima toxin concentrations were observed in mussels (*Mytilus*) of Concarneau bay with 14 130 µg/kg, and in *Donax* of Douarnenez bay, with 4790 µg/kg, both sites situated in Southern Brittany.

Alexandrium and paralytic (PSP) toxins

Alexandrium was observed every year during the 2011–2013 period on a large part of the French coast. Species were generally identified as genus *Alexandrium*, or *A. minutum*, sometimes as *A. affine* or *A. ostenfeldii*. The annual maxima were generally below 100 000 cells/L, but blooms above 100 000 cells/L were regularly observed in a few sites of Northern and Western Brittany, always in summer. PSP toxic episodes were associated or not to these blooms.

The PSP toxic episodes, defined from results above the official sanitary threshold (which is 800 µg/kg of equ.STX according to the European Directives), are described per year below.

2011 - There was no PSP toxic episode in 2011 in France.

2012 - In Brest bay (Western Brittany), a bloom of *Alexandrium* was observed with very high cell counts, up to 41 740 000 cells/L. The maxima toxin concentrations observed during the PSP episode which followed this bloom, reached 8320 µg/kg in mussels (*Mytilus*) and 1730 µg/kg in oysters (*Crassostrea gigas*).

2013 - Blooms of *Alexandrium* were observed in and around Brest bay, but they were less important than in 2012 (max 120 000 cells/L). The maximum toxin concentration observed during the PSP episode was 1370 µg/kg in mussels (*Mytilus*) of the Abers (at the North of Brest).

Pseudo-nitzschia and amnesic (ASP) toxins

Pseudo-nitzschia was observed every year on the whole French coast, with annual maxima always above 100 000 cells/L and often above one million cells/L. Blooms could be due to many different species, often identified as « belonging to the complex... (*americana*, *delicatissima*, *seriata*, etc) ». Most of the time, toxic and non-toxic species were mixed in the samples. Studies have shown that *Pseudo-nitzschia australis* had sometimes been linked to ASP toxic episodes. Blooms periods were essentially between April and June. ASP episodes were associated or not to these blooms.

The ASP toxic episodes, defined from results above the official sanitary threshold (which is 20 mg/kg of equ. DA according to the European Directives), are described per year below (see Fig. 2 for an illustration for 2011 and 2012). During the three years, ASP toxic episodes affected primarily scallops (*Pecten maximus*).

2011 - ASP toxic episodes concerned the scallops of the Seine bay in Channel, and in Atlantic those of South Brittany and between the rivers Loire and Gironde. The maximum toxin concentration was observed in Belle Ile (South Brittany) with 240 mg/kg.

2012 - ASP toxic episodes concerned the scallops of the Seine bay in Channel, and in Atlantic those of South Brittany and between the rivers Loire and Gironde. Only one episode affected *donax* in Western Brittany. The maximum toxin concentration was observed in scallops of the Seine bay with 300 mg/kg.

2013 - ASP toxic episodes concerned the scallops of the Seine bay in Channel, and those of South Brittany in Atlantic. The maximum toxin concentration was observed in scallops of the Seine bay with 220 mg/kg.

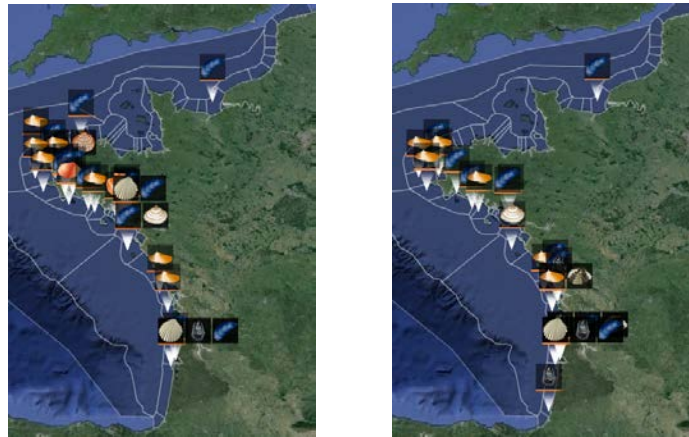


Figure 1. Occurrences of diarrhetic (DSP) toxic episodes in 2011 and 2012: zones and shellfish for which results were above the sanitary threshold for the group OA+DTXs+PTXs (160 µg/kg of equ. OA).

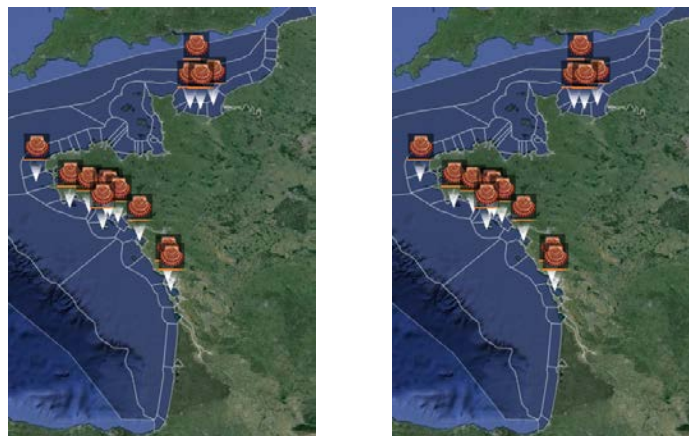


Figure 2. Occurrences of amnesic (ASP) toxic episodes in 2011 and 2012: zones and shellfish for which results were above the sanitary threshold for ASP (20 mg/kg of equ. DA).

4.5 Germany National Report 2011–2013

Allan Cembella

German coastal waters are monitored for HAB events and associated toxicity in shellfish primarily by a combination of state and local environmental authorities and private laboratories for seafood safety. In addition, key information is provided via long term phytoplankton monitoring, including HAB taxa, at Helgoland (Roads) in the southern German Bight and the Wattenmeerstation Sylt on the eastern Wadden Sea coast. Reporting regions for HAEDAT for Germany have been sub-divided as follows: Mecklenburg-Western Pomerania coast of the south-eastern German Baltic (DE01); eastern coast of Schleswig-Holstein, including Kattegat, Kiel Bight and Flensburg Fjord (DE02); north Frisian Coast of Schleswig-Holstein and eastern Wadden Sea (DE03); and the southern German Bight and Wadden Sea coast of Lower Saxony, and including Helgoland (DE04). There is no national coordinated monitoring strategy for HAB and associated toxins and harmful events in Germany, therefore reliable time-series data are generally not available. Due to the lack of aquaculture and absence of measureable effects on fisheries and other marine resources in German coastal waters, harmful algal events are typically associated with socio-economic effects on tourism caused by beach fouling and degraded bathing water quality, particularly from cyanobacterial blooms along the Baltic coast. Germany is particularly concerned about the health consequences of imported seafood contaminated with phycotoxins, rather than production from local waters.

2011

There were no unusual or remarkable HAB events to note in German coastal waters during this year. Typical events associated with beach fouling by cyanobacterial blooms were recorded along the German Baltic coast, especially high densities of *Nodularia* sp. during summer.

2012

No dramatic high magnitude HAB events were associated with high toxicity in shellfish or faunal mortalities from German coastal waters in 2012. An exceptional bloom of *Phaeocystis globosa* occurred in the Wadden Sea from the end of May until the beginning of June, 2012, but did not cause apparent harm. Similarly, a red-tide bloom of *Noctiluca miliaris* was notable by high surface cell concentrations within the southern German Bight and Wadden Sea (DE04) at the end of June, but without obvious ecological consequences. A wide diversity of HAB species were observed in the eastern Wadden Sea (DE03), although not at bloom cell concentrations: *Alexandrium tamarense*, *A. ostenfeldii*, *Dinophysis acuminata*, *D. acuta*, *D. norvegica*, *Heterocapsa* spp. (possibly included *Azadinium* spp.), *Noctiluca miliaris*, *Pseudo-nitzschia delicatissima*-complex, *Pseudo-nitzschia pungens*-complex and *Phaeocystis globosa*.

Shellfish toxin monitoring from German coast

ASP-, DSP-, PSP-toxin type

A total of 231 samples were analysed from the North Sea (192 mussels, 23 oysters) and the western Baltic Sea (16 mussels), and all yielded toxin levels below the respective regulatory limits. In September 2012, two mussel samples collected near Sylt island in the Wadden Sea did contain okadaic acid and esters (max. 65 µg/kg). In other shellfish samples no appreciable toxins were found.

Cyanobacterial blooms in the Baltic Sea

The German Baltic coast is typically subject to high magnitude cyanobacterial blooms every summer, often causing noxious fouling of beaches. In 2012, during an oceanographic cruise through the first three weeks of July, the expected development of a large-scale cyanobacterial bloom in the Eastern Gotland Sea and the northern Baltic Proper failed to appear in high magnitude. During a subsequent monitoring cruise (end of July to early August) from Kiel Bight to the northern Baltic Proper, only a few cyanobacteria aggregates were visible in the water and no bloom appeared in the investigated areas of the Baltic Proper (except for the Arkona Sea and Pomeranian Bight).

Ciguatoxins in fish imported to Germany

Six persons in various regions in Germany fell ill after consuming imported red snapper distributed via fish processing company in Bremerhaven. The red snapper originated from the Indian Ocean and various source countries were identified (India, Sri Lanka, Vietnam), but the exact origin of the toxic fish could not be established. The symptoms in the affected persons who ate the contaminated fish were exactly consistent with ciguatera fish poisoning (CFP). The presence of ciguatoxin analogues (e.g. CTX1B) was subsequently confirmed by the German Bundesinstitut für Risikobewertung (BfR) and the European Reference Laboratory for Marine Biotoxins and these human cases are now considered to have been correctly attributed to CFP.

2013

A high diversity of HAB species were recorded from weekly observations in the eastern Wadden Sea near Sylt (DE02) albeit not at bloom cell concentrations. The following HAB taxa were detected in sub-bloom concentrations but were not associated with toxins above regulatory limits: *Alexandrium tamarense*/A. *ostenfeldii*, *Azadinium* spp., *Dinophysis acuminata*, *D. acuta*, *D. norvegica*, *Karenia*/Karlodinium morphotypes – not identified to species, *Chrysochromulina* spp., *Fibrocapsa* sp., *Chattonella* sp., *Pseudochattonella*, including the flagellated stage of *Dictyocha speculum*, and *Pseudo-nitzschia pungens*-complex. Significant but not spectacular surface blooms of *Noctiluca* und *Phaeocystis* were also observed but were not linked with negative environmental consequences.

During an annual oceanographic cruise from Kiel Bight to the northern Baltic Proper (DE01, DE02) typical cyanobacteria blooms, e.g. of *Nodularia spumigena* were observed in mid-summer in the Baltic. Cyanobacterial blooms occurred only irregularly in the west-

ern Baltic and coast of Mecklenburg-Western Pomerania. Nevertheless, high cell concentrations of cyanobacterial blooms in coastal regions of Mecklenburg- Western Pomerania greatly impaired bathing water quality. In July, 2013 measured nodularin concentrations in the Bornholm Sea (55°15' N; 15°59' E) attained 22 µg/g dry mass and in the Fårö Deep, north-east of Gotland (58°0' N; 19°54'E) reached 800 µg/g dry mass of cyanobacteria. In early July, coastal and beach areas near Heligendamm were badly affected by high biomass caused by wind-induced transportation of surface patches, including *Nodularia spumigena* (2060 mg/m³), *Mesodinium rubrum* (472 mg/m³) and *Aphanizomenon* sp. (336 mg/m³).



Figure 1 Designation of sampling regions for HAB blooms and associated harmful events for German coastal waters.

4.6 The Netherlands National Report 2011–2013

During 2011–2013 the shellfish production areas; North Sea, Lake Grevelingen, Wadden Sea, Oosterschelde and Veerse Meer were monitored for the presence of toxic phytoplankton. This program was based on the National Shellfish Food Safety Program on a monthly basis from November until April and a weekly basis from May until October.

2011

Dinophysis acuminata was detected in lake Grevelingen during the second half of May at concentrations ranging from 130 to 290 cells/L in the surface samples and ranging from 120 to 170 cells/L in bottom samples. Samples from the north area in the North Sea revealed during the last week of august a *D. acuminata* concentration of 380 cells/L. Concentrations during the following week were below detection limit. In the mid-section of the Wadden Sea, *D. acuminata* concentrations above threshold level were found during the last half of august. Week 33 presented the highest concentrations of 330 cells/L. Concentrations of this species decreased during the following two weeks to 140 cells/L and presented values below detection limit by mid-September. Concentration under the threshold limit for this species (100 cells/L) were reported for the Veerse Meer in September and for the Oosterschelde in November.

Pseudo-nitzschia sp. were found in all the location areas from July up to October, nevertheless, all the measured concentrations were well below the threshold limit of 500 000 cells/L. The highest concentrations for this species, 83 000 cells/L were recorded at the beginning of October in the lake Grevelingen. Concentrations in the Wadden Sea reached the highest value, 46 000 cells/L in September.

In some cases *D. rotundata* was reported in the north and middle areas of the Wadden Sea but always at very low concentrations.

All sites were also sampled for marine biotoxins, and analysed with LC-MS/MS. 2–3 times trace levels of DSP were found, but always below the report limit of 20 µg OA-eq/kg (regulatory limit is 160 µg OA-eq/kg).

2012

In the whole period of 2012 no toxins were found in the Netherlands in the routine Shellfish monitoring program. There have been two occasions of toxicity besides the regular monitoring. One was found in shellfish traded from Ireland, and relayed in the Oosterschelde. The second was a bloom of *Alexandrium ostenfeldii* in a creek/polder system. Both events are separately described in the new findings.

Dinophysis acuminata was detected in Lake Grevelingen during the last week of August till mid-October. The threshold (100 cells/litre) was exceeded during August and September, with maximum densities in mid-September peaking at 1.300 cells/litre, whereas 200–300 cells per litre was common in that period.

The North Sea is monitored from February through October. Only one occasion of 19 cells of *D. acuminata* was found. In the Oosterschelde *D. acuminata* was found in background (<20 cells/L) concentrations in September. In Lake Veere 3 weeks of prevalence of *D. acuminata* is recorded. In the first week cell densities were just above the threshold value (105 cells/L), where the second week it peaked to 1.200 cells/L, followed by a decrease to 42 cells per liter. Then *D. acuminata* temporarily disappeared, and reappeared in September and October, peaking in the third week at 100 cells /l. *D. acuminata* is found in the Waddensea at three occasions at background concentrations below 35 cells/l.

Pseudo-nitzschia sp. is found in many samples (figure NL). No thresholds are exceeded in 2012. The threshold is 500 000 cells/L as an Early Warning indicator. The highest values are found in Lake Grevelingen at 185 000 and 105 000 cells/L.

2013

In 2013 no toxic events occurred in the coast of the Netherlands. In some occasions *Dinophysis acuminata* was detected above the 100 cells/litre threshold. These occasions were seen in the Wadden Sea (figure NLc). In this period no toxins above the regulatory limit were detected.

In contrast to the episode of *Alexandrium ostenfeldii* in the creek system adjacent to the Oosterschelde, this year no events occurred. *A. ostenfeldii* was present in the creek system, which was detected during intensive monitoring. However, no high values were detected in the Eastern Scheldt nearby the mussel plots.

Pseudo-nitzschia sp. was detected in numbers which did not exceed 300 000 cells per liter. This is well below the new (2011) threshold value of 500 000 cells/litre. LC-MS analysis could not show any Domoic Acid (or derivatives).

A shore survey performed by RIKILT, Wageningen UR was done along the Dutch central shoreline. Water samples were analysed for presence of lipophilic toxins. During this survey 2 out of 13 samples were found positive on traces of Azaspiracid (Gerssens, pers. comm).

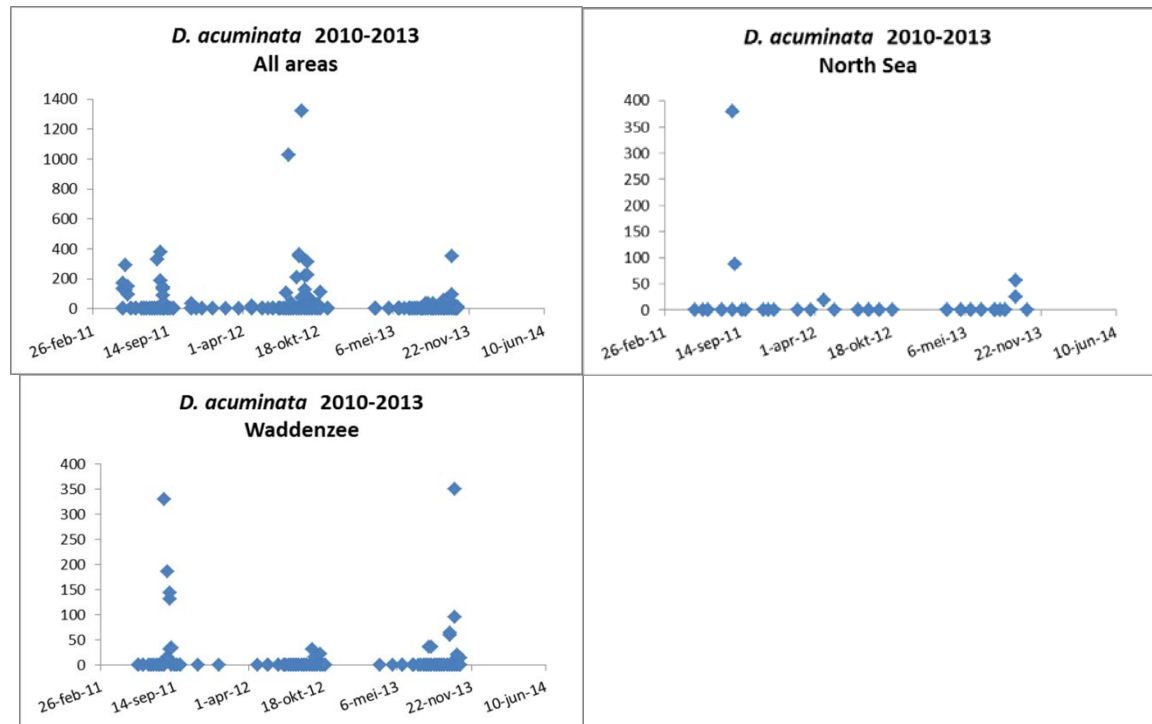


Figure NL. *Dinophysis acuminata* results of the national shellfish monitoring program 2010–2013. a) All areas, b) North Sea, and c) Wadden Sea.

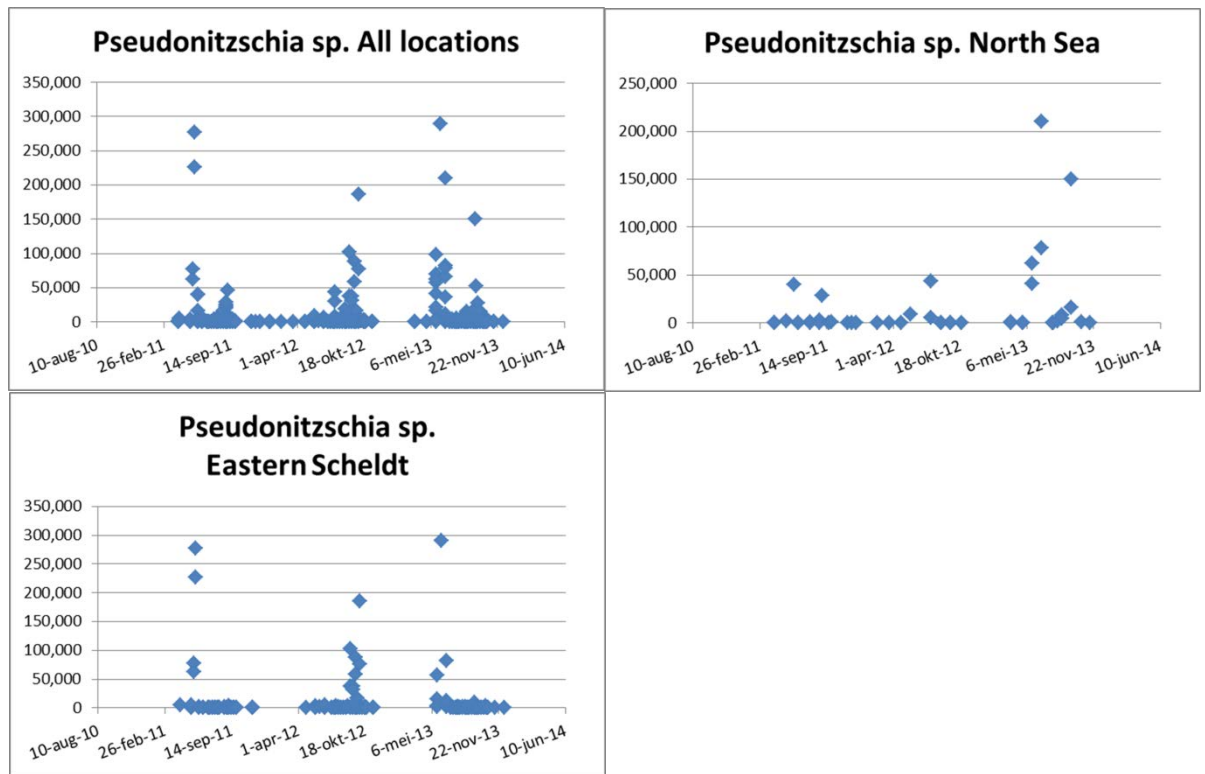
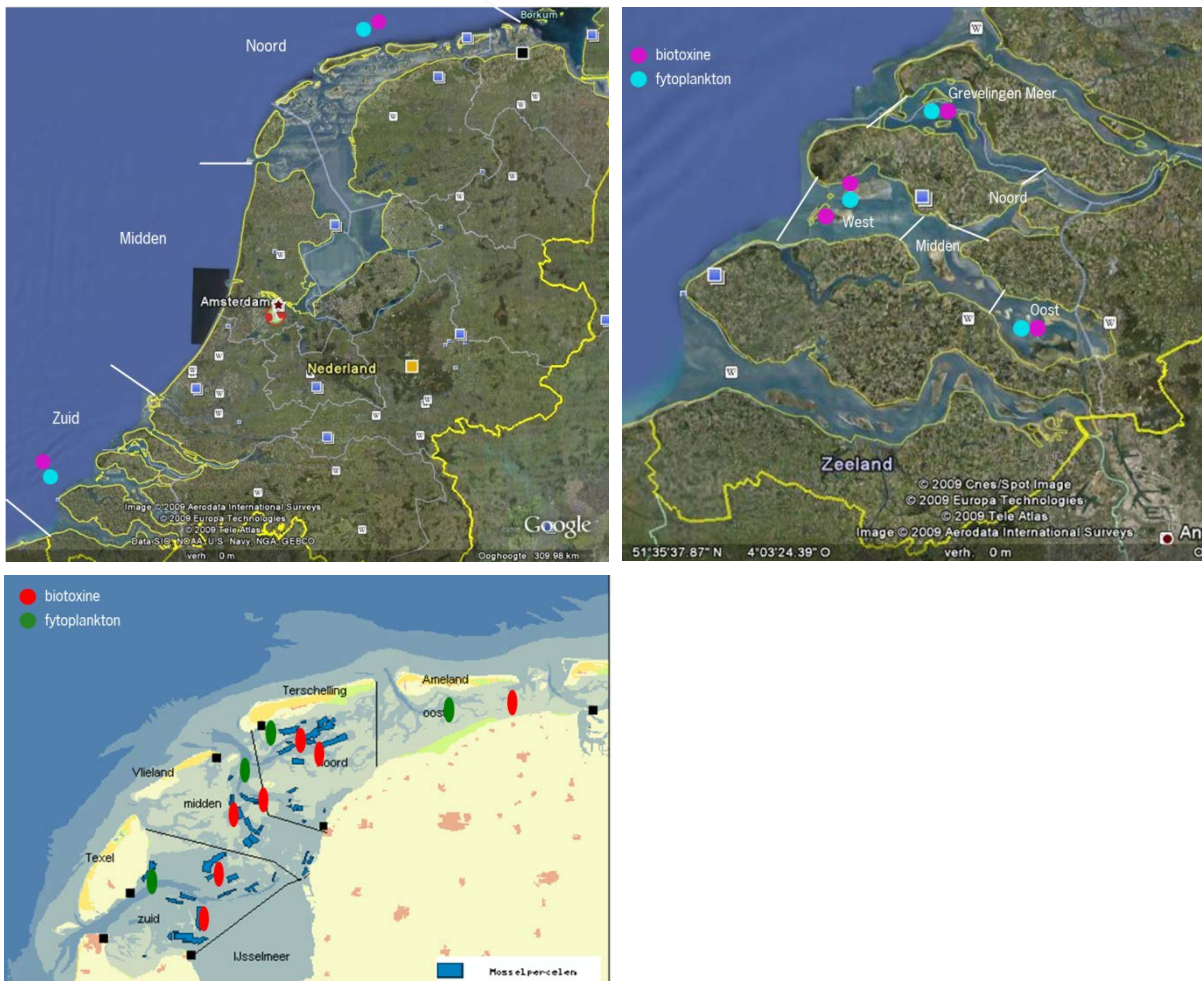


Figure NL. *Pseudo-nitzschia* spp. results of the national shellfish monitoring program 2010–2013.
a) All areas, b) North Sea, and c) Eastern Scheldt.

MAPS



Sampling locations Dutch Monitoring System for shellfish food safety purposes. North Sea coastal zone, Southern Delta, and Wadden Sea.

4.7 Poland National Report 2011–2013

Hannah Mazur-Marzec

In years 2011–2013 the blooms of cyanobacteria, including the toxic species *Nodularia spumigena* and the dinoflagellates *Alexandrium* sp. were observed in the eastern part of the Polish zone of the Baltic Sea (Gulf of Gdansk).

Nodularia spumigena and other cyanobacteria

2011

The highest biomass of *N. spumigena* (1,531.5 µg/L) and the highest concentration of nodularin (1,250 µg/L) in coastal waters were observed on 30 June. It resulted in short closure of some beaches in the area affected by the bloom. In the sample collected on that day, *Aphanizomenon flos-aquae* (84,350 µg/L) and *Dolichospermum* spp. (5,606 µg/L) were also present.

In mussels, the average nodularin (NOD) content was 530 ng/g dw (24 August). In fish muscles it temporarily reached 920.9±1769.1 ng/g dw in round goby (29 July) and 191.8±87.3 ng/g dw in flounder (29 July).

2012

In the beginning of July, the biomass of *N. spumigena* (141,205.36 µg/L), *A. flos-aquae* (36,465.46 µg/L) and *Dolichospermum* spp. (19,443.92 µg/L) reached its highest values. The event was associated with beach closures. In cyanobacterial material collected close to the beaches during the bloom (5–6 July), the concentrations of NOD ranged from 293 µg/L – 45,000 µg/L.

2013

In coastal waters off Gdynia (Gulf of Gdansk), the cyanobacteria developed into bloom on 9 July. As usual, among the filamentous species *N. spumigena* (34,432 µg/L), *A. flos-aquae* (308.41 µg/L) and *Dolichospermum* spp. (153.92 µg/L) dominated. The maximum concentration of NOD detected this year was 30.0 µg/L. The bloom was rather short and lasted for about one week.

Alexandrium spp.

2011 – no records

2012

The bioluminescent bloom of *Alexandrium ostenfeldii* in Puck Bay (Gulf of Gdansk) was observed at the turn of August and September. The maximum cell number was 850,000 cells/L. Two PSP toxins were detected in *A. ostenfeldii* cells: STX and GTX. In fish (round

goby) collected during the bloom, the total PST concentration was within 0.5–1.0 µg/100 g in muscles and within 20–30 µg/100 g in viscera.

2013

Similarly to the previous year, *Alexandrium* was observed in Puck Bay at the turn of August and September. Two species: *A. ostenfeldii* (120–900 cell/L) and *A. tamarense* (60–140 cell/L) were identified.

Table: HAB events in the eastern part of Polish coast (Baltic Sea).

Year	<i>Nodularia spumigena</i> max biomass [µg/L]	NOD [µg/L]	Comment	<i>Alexandrium</i> max abundance [cell/L]	PST	Comment
2011	1,531.5	1,250	Beach closure caused bay cyanobacteria bloom (30 June)	-	-	
2012	141,205.36	45,000	Beach closure caused bay cyanobacteria bloom (5–6 July)	<i>A. ostenfeldii</i> - 850,000	STX GTX2/3	PST in fish at max 30 µg/100 g
2013	34,432	300	Beach closure caused bay cyanobacteria bloom (9 July)	<i>A. ostenfeldii</i> -900 <i>A. tamarense</i> -		

4.8 Portugal National Report 2011–2013

M.T. Moita and M.A. Branco, IPMA

The Portuguese Monitoring of HABs and phytotoxins, conducted by IPMA (Portuguese Institute for the Sea and Atmosphere, www.ipma.pt/), covers the whole coast of Portugal except Madeira and Azores archipelagos where there is no official monitoring.

During the first half of 2011 no relevant blooms or any episodes of toxicity in shellfish were observed on the NW and SW coasts, while the S coast presented DSP events since mid-March. On the contrary, 2012 was considered an atypical year concerning the location and timing of the blooms: (i) along the NW coast, blooms mainly occurred in the first half of the year; (ii) on the S coast, blooms were quite continuous from May until mid-November and caused by a succession of different species (*Dinophysis acuminata*, *Dinophysis acuta*, *Gymnodinium catenatum*, *Pseudonitzschia c.f. australis*, *Lingulodinium polyedra*) in space and time. The year of 2013 was characterized by persistent DSP events related to *D. acuminata* proliferations.

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PSP

In 2011, *G. catenatum* blooms mainly occurred on the NW coast reaching 5.6×10^3 cells L^{-1} and $3300 \mu g$ STX Kg^{-1} off Aveiro in autumn. In opposition to the previous years, e.g. 2011, in 2012 PSP outbreaks were observed along the S coast where several *G. catenatum* maxima were observed (151×10^3 cells L^{-1} in July and 12×10^3 cells L^{-1} in August) in parallel with elevated levels of PSP toxins (5790 and $8140 \mu g$ STX Kg^{-1} detected in *Donax* spp.).

In 2013 there were no PSP outbreaks along the Portuguese continental waters, although some high concentrations of *Gymnodinium catenatum* (2×10^3 cells L^{-1}), observed on the S coast in July, did not produce any toxicity in shellfish, probably because the blooms were located at the surface.

PSP in Açores islands. Despite the inexistence of an official monitoring program in the Azores islands, some water samples collected on the 2nd September 2013 at the Santo Cristo coastal lagoon, in São Jorge island, were received at IPMA. It was identified a bloom of *Alexandrium* c.f. *minutum* with a concentration as high as 1.26×10^7 cells L^{-1} . This bloom was simultaneous with fish kills (*Mugil cephalus*) whose guts contained $2132 \pm 377 \mu g$ STX equiv. Kg^{-1} , although no toxins have been detected in muscle. Very high levels of toxins ($24445 \mu g$ STX equiv. Kg^{-1}) were detected in clams (*Tapes decussatus*) collected two weeks later in the lagoon, exceeding 30 times the regulatory limits. This is, as far as we know, the first reported bloom of *Alexandrium minutum* in middle N Atlantic (Santos *et al.*, submit.).

DSP

The years 2011–2013 were characterized by an increase of DSP outbreaks on the S coast. On the NW coast, in 2011, *Dinophysis* blooms mainly occurred in the second half of the year. On the contrary, in 2012 they occurred much earlier, from February until July. In 2013, they lasted for a longer period, from April to December. 2011–2013 period was dominated in space and time by the *D. acuminata* outbreaks when compared with the

short events of *D. acuta*, a fact that is probably related to these particularly rainy years in Portugal. The SW coast was characterized by a clear increase of the weeks of closure related to DSP events: 8 weeks in 2011, 15 in 2012 and 29 in 2013. Thus, 2013 was a year characterized by persistent *D. acuminata* blooms that were initiated in April and lasted intermittently until December. A further relevant outbreak was related to *D. acuminata* that occurred for three weeks, in January, on a semi-enclosed coastal lagoon and adjacent coastal waters.

NW coast. As pointed above, 2011 and 2012 were contrasting years in what concerns the time and concentration of *D. acuminata* blooms. In 2011, the maxima observed were normally low and the highest concentration was 0.5×10^3 cells L⁻¹ off Aveiro, at the end of August. Despite the low concentrations detected, shellfish harvesting closure lasted from July until December. In 2012, *D. acuminata* attained 6×10^3 cells L⁻¹ in April that was responsible for maxima of toxicity that reached 5420 and 3150 µg OA equiv. Kg⁻¹ in *Mytilus galloprovincialis*, inside Ria de Aveiro and off F.Foz, respectively.

During 2013 there was a long closure period of shellfish harvesting due to DSTs that lasted from April to December. Several major peaks occurred: on the 1st August, *D. acuminata* reached 1.8×10^3 cells L⁻¹ off Porto followed by a maximum of 10×10^3 cells L⁻¹ located at Leirosa, about 110km south, one month later; at the end of September/beginning October. *D. acuminata* attained concentrations of 2.3×10^3 cells L⁻¹. At mid September there was an event of *D. acuta*, off Aveiro, with a maximum of 4.6×10^3 cells L⁻¹ that lasted just one week.

Center/SW coast. In 2011, the central west coast was closed to harvesting during a short period of 8 weeks (September -October) and *D. acuminata* reached 0.25×10^3 cells L⁻¹ corresponding to 306 µg OA equiv. Kg⁻¹ in mussels.

From 8 August to 16 November 2012 a shellfish closure was due to the development of *D. acuta* populations that reached 6×10^3 cells L⁻¹ in Lisbon bay. As a consequence, a maximum of 2190 µg OA equiv. Kg⁻¹ was observed in *Donax* spp..

A short two weeks event was observed in the Lisbon bay in April 2013 with a low concentration of 160 cells L⁻¹ of *D. acuminata*. Later, in July, a particular intense bloom (18.6×10^3 cells L⁻¹) of *D. acuminata* coincided with an event of *D. acuta* with smaller concentrations (780 cells L⁻¹) and originated a long period of shellfish closure until December.

Costal lagoons in SW coast

(i) Lagoa de Óbidos, a semi-enclosed coastal lagoon, was banned to harvesting during the last week of October 2013 due to *D. acuminata* proliferation (max 220 cells L⁻¹) associated with values of 186 µg OA equiv. Kg⁻¹ in cockles (*Cerastoderma edule*). In 2012, this lagoon has been closed two weeks in February and also in June due to *D. acuminata* proliferations (max 2.7×10^3 cells L⁻¹) associated with values of 462 µg OA equiv. Kg⁻¹ in *M. galloprovincialis*.

(ii) Lagoa de Albufeira, a coastal lagoon located at the coast of Lisbon Bay, was closed in August and September 2012 due to *D. acuta* (max.: 2.4×10^3 cells L⁻¹) that was responsible for a high concentrations of 724 µg OA equiv. Kg⁻¹, detected in mussels. In January 2013, a low concentration bloom of *D. acuminata* (280 cells L⁻¹) was detected associated with values of 243 µg OA equiv. Kg⁻¹ in mussels (*M. galloprovincialis*), and the lagoon was

closed to harvesting during 3 weeks. Later, in July, an intense *D. acuminata* bloom reached 33×10^3 cells L^{-1} and the lagoon remained closed until December.

S coast. Three major events were observed during 2011, all related with *D. acuminata* outbreaks. The first bloom reached 1.5×10^3 cells L^{-1} at Sagres (west side of the S coast) in April. A toxin maximum of 3100 μg OA equiv. Kg^{-1} was although observed in *Donax* clams off Faro, associated with low concentrations of *D. acuminata* cells (0.44 cells L^{-1}). The second peak occurred in August (0.6×10^3 cells L^{-1}) and the third in late September (0.2×10^3 cells L^{-1}), with toxins reaching 269 and 316 μg OA equiv. Kg^{-1} in *Donax*, respectively.

In 2012, the maxima of DSP was 532 μg OA equiv. Kg^{-1} detected in *M. galloprovincialis* in May due to *D. acuminata* (max. 2.2×10^3 cells L^{-1}). Another peak (378 μg OA equiv. Kg^{-1} in *Donax*) was observed in October due to both *D. acuta* and *D. acuminata* that reached, respectively, 1.3×10^3 cells L^{-1} and 2.8×10^3 cells L^{-1} .

In 2013, the coast was closed to harvesting from April until the beginning of October. Intermittent events of *D. acuminata* were observed, although peaks never exceeded 0.9×10^3 cells L^{-1} . Concentrations of DSP toxins in this coast were much lower than in previous years and reached 325 μg OA equiv. Kg^{-1} in *Donax* on the 17 June.

ASP

All the toxic events observed from 2011 to 2013 were related to the presence of *Pseudo-nitzschia* c.f. *australis*.

At the end of September 2011, a short two weeks event of *P. australis* was observed off Aveiro (NW coast) with a maximum of 319×10^3 cells L^{-1} , responsible for levels of 31 mg DA Kg^{-1} in white clams.

Compared with the previous years that were characterized by short events of ASP, 2012 had a significant bloom that lasted more than one month. On the NW coast, a very short one week outbreak was due to a peak of 196×10^3 cells L^{-1} . On the S coast, a longer period of shellfish harvesting closure occurred (from 4 June till 9 July), with *Pseudo-nitzschia* spp. reaching 1.5×10^6 cells L^{-1} on 19 June. This closure coincided with a maximum of 120 mg DA Kg^{-1} observed in mussels.

Two peaks of *P. australis* were observed from May to July 2013, on the NW coast between Aveiro and F.Foz, reaching 70×10^3 cells L^{-1} and 100×10^3 cells L^{-1} respectively. During this event a maximum of 36.8 mg DA Kg^{-1} was observed in mussels, a closure that lasted only one week. A later episode was detected from mid-August until the end of September, at the same region. *P. australis* attained two maxima of 225×10^3 cells L^{-1} and 171×10^3 cells L^{-1} on 27 August and 10 September. The highest ASP event was observed in clams inside Ria de Aveiro where concentrations reached 64.5 mg DA Kg^{-1} . On the S coast two events occurred, a first in winter and a second during one week in June. *P. australis* reached 105×10^3 cells L^{-1} on 28 February corresponding to a maximum of 41 mg DA Kg^{-1} in mussels. The second peak attained 90×10^3 cells L^{-1} on 11 June and the closure decision was based on the concentrations of *Pseudo-nitzschia* cells.

YTX producing species

Since the last major 2005 bloom in Lisbon bay, the new detected high concentrations of *L. polyedra* were observed in 2012 along the eastern area of the S coast of Portugal. The blooms were detected on 18 July in the mouth of Guadiana river (S Portuguese/Spanish boarder) and lasted until 23 October reaching 11×10^6 cells L^{-1} on 20 July at Olhão coast. No blooms were observed either in 2011 or 2013.

Benthic HABs

The first reported outbreak was observed at D. Ana beach, at the south coast of Portugal, in 2011. This bloom reached densities of 5420 cells L^{-1} in water samples, although concentrations remained lower (40 to 320 cells L^{-1}) in adjacent areas. In a coastal management context, local authorities closed several beaches for bathing during 5 days once informed about the bloom occurrence and model predictions for its transport (David *et al.*, 2012, HAN45). Only one case of respiratory and skin irritation was reported. No blooms of *Ostreopsis cf. ovata* were detected in 2012.

The second bloom of *Ostreopsis cf. ovata* occurred at the same beach from 3 September until 15 October 2013. The bloom reached 16×10^3 cells L^{-1} in water samples collected in 16 September and the highest concentrations were observed in seawater temperatures between 24 and 25 °C. The concentration of the maximum was 3 times higher than the one observed in 2011. There were no human complaints reported.

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4.9 Spain National Report 2011–2013

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* Based on information provided by the following institutions: ¹Laboratorio de Control de Calidad de Recursos Pesqueros (LCCRRPP), Huelva, Autonomous Community of Andalucía. <https://ws128.juntadeandalucia.es/agriculturaypesca/moluwe>; ²AZTI-Tecnalia in cooperation with the University of the Basque Country (UPV). Autonomous Community of the Basque Country. (<http://www.azti.es/>); ³IRTA (Research and Technology Institute for Agriculture and Food). <http://www.irta.cat/ca-ES/RIT/A/A3/Pagines/A31.aspx>, Autonomous Community of Catalonia (monitoring of shellfish and fish production areas). ⁴Grupo de Investigación en Procesos Biológicos Litorales, Instituto de Ciencias del Mar (CSIC, Barcelona) (monitoring of benthic HABs and water quality in ports and beaches) <http://pbl.cmima.csic.es/es/content/portada> funded by the Catalan Water Agency (ACA). ⁵Instituto Tecnológico para o Control do Medio Mariño de Galicia" (INTECMAR) (www.intecmar.org), Autonomous Government of Galicia. In addition to punctual comments from Carolina Pérez from the Banco Español de Algas (BEA) <http://bea.marinebiotechnology.org/en>

ANDALUCIA: Atlantic (ES 09–ES 11) and Mediterranean (ES 12–ES 15)**PSP**

2011. *Gymnodinium catenatum* spread through the whole Mediterranean coast of Andalucía (Cádiz to Almería). A first bloom appeared in July off Málaga (max. $15 \cdot 10^3$ cell·L⁻¹), and a more intense one, from October to December, exhibited maximum densities ($48.4 \cdot 10^3$ cell·L⁻¹) and toxin levels in shellfish off Cádiz.

2012. Harvesting bans for several bivalve species caused by *Gymnodinium catenatum* in both, Atlantic and Mediterranean coasts. This species exhibited a bimodal summer growth season in Huelva (Atlantic coast), with a first peak in mid-July (max. $25 \cdot 10^3$ cell·L⁻¹) and a second in August (max. $19.4 \cdot 10^3$ cell·L⁻¹). On the Mediterranean shores, it bloomed in August, with cell maxima of $19.4 \cdot 10^3$ cell·L⁻¹ and $19.8 \cdot 10^3$ cell·L⁻¹ in Cádiz and Málaga respectively.

2013. High levels (max $9.6 \cdot 10^3$ cell·L⁻¹) of *G. catenatum*, more persistent and intense on the eastern shores, were found in Huelva (Atlantic) in October. On the Mediterranean coast, *G. catenatum* was detected all year round. Maximum densities ($12.4 \cdot 10^3$ cell·L⁻¹) were found in January, July and November-December. PSP toxins above regulatory levels detected in winter (January-March) as well as in late autumn (November-early December).

Conclusion 2011–2013: *G. catenatum* blooms causing PSP events are endemic on the Mediterranean coast of Andalucía but only occasionally found on the Atlantic shores. Nevertheless, blooms exhibited a similar intensity in both sides during 2 (2012, 2013) out of these 3 years.

DSP

2011. A *Dinophysis acuminata* event in March off Huelva (max. $30.7 \cdot 10^3$ cell·L⁻¹) led to closures of the whole production area. On the Mediterranean coast, this species was detected from late June to early July off Málaga (max. $4.1 \cdot 10^3$ cell·L⁻¹) and was associated with positive results for lipophilic toxins in shellfish.

2012. First *D. acuminata* event in mid-May in Huelva, more intense to the west (Portuguese Algarve border) (max. $5.1 \cdot 10^3$ cell·L⁻¹) with closures of some shellfish production areas. Blooms of *D. acuta* (max. $2 \cdot 10^3$ cell·L⁻¹) in mid-July combined with several peaks of *D. acuminata* in August and early September led to an almost full closure of all production areas on the Atlantic shores.

D. acuminata densities increased during June-July but showed lower densities on the Mediterranean sites. Maximal densities of 720 and 1440 cell·L⁻¹ in Cádiz and Málaga respectively. Toxins above regulatory limits in several shellfish species in both provinces.

2013. There were two blooms of *D. acuminata* in Huelva province, the first in April to early May (annual maximum, $3.3 \cdot 10^3$ cell·L⁻¹) and the second in July (max. $2.3 \cdot 10^3$ cell·L⁻¹). There was a third minor bloom in restricted areas in December. Associated harvesting bans took place between May and August, and again in December. On the Mediterranean coast, *D. acuminata* bloomed off Cádiz in July, more intensely in the easternmost parts of the province ($> 10^3 \cdot 10^3$ cell·L⁻¹). Toxins were above regulatory levels since July and until December in some areas. In Málaga (max. $3 \cdot 10^3$ cell·L⁻¹) and Almería ($1.2 \cdot 10^3$ cell·L⁻¹)

blooms of *D. acuminata* were found in July and August, and positive results appeared intermittently between July and November in some areas.

Conclusion 2011–2013: Blooms of *D. acuminata* are endemic on the whole Andalusian coast, but events are more intense on the Atlantic side. Nevertheless during 2013, DSP events on the Mediterranean side were more intense than usual. DSP outbreaks are specially hard on the Atlantic side when there is a combination of blooms of *D. acuminata* followed by *D. acuta* as it was the case in 2012.

ASP

2011. *Pseudo-nitzschia* spp. detected all year round with different peaks and troughs, but domoic acid in shellfish kept below detection levels.

2012. Blooms of *Pseudo-nitzschia* cf *australis* in Huelva during June (max. $2.4 \cdot 10^5$ cell·L⁻¹) caused closures in several production areas. Maximal densities of *Pseudo-nitzschia australis* off Cádiz ($2.4 \cdot 10^5$ cell·L⁻¹) and Málaga ($4.4 \cdot 10^5$ cell·L⁻¹) were observed from late April to early May and there were harvesting bans in both provinces.

2013. There was a *Pseudo-nitzschia* cf *australis* event and associated harvesting bans in Huelva in February, more intense (max. $2.2 \cdot 10^5$ cell·L⁻¹) in the middle and eastern parts of the province. On the Med side, cell maxima ($2.2 \cdot 10^5$ cell·L⁻¹) were observed also in February. Toxin levels above regulatory level were found only in the provinces of Málaga and Cádiz (western end).

Conclusion 2011–2013. Blooms of *Pseudo-nitzschia* cf *australis* ($>10^5$ cell·L⁻¹), not always associated with short ASP outbreaks (as it was the case in 2011) are common in the whole Andalusian coast.

GALICIA: Rías Altas (ES 05–06) and Rías Baixas (ES 07–08)

PSP

2011 *Alexandrium minutum in situ* growth produced closures of infaunal molluscs in Ría de Camariñas (Rías Altas) in May. Maximum values were toxin levels were 1360 µg equiv STX di.HCl/Kg and $11.9 \cdot 10^3$ cell·L⁻¹ on 9th May. *A. minutum in situ* growth in the estuary of Baiona (R. Vigo), caused closures of raft mussels in June and uninterrupted closures of infaunal shellfish from May to October. Max. 7900 µg equiv STX di.HCl/Kg on 2nd May and $2.7 \cdot 10^5$ cell·L⁻¹ on 23rd May.

In situ growth of *Gymnodinium catenatum* detected in June in Ria de Pontevedra (max $1.4 \cdot 10^3$ cell·L⁻¹ at st. P4 on 18th July) and produced a short-term closure in July (st. Portonovo B). This bloom spread to all production areas of Portonovo (Pontevedra) in August and September. During October, closures affected the whole Ria de Pontevedra and during November and December, the Ria de Muros, middle and outer reaches of Arousa, all Ría de Pontevedra and outer reaches of Ria de Vigo. In Ria de Pontevedra, infaunal molluscs were also affected. Maximum values were $51.8 \cdot 10^3$ cell·L⁻¹ on 31st October at the surface and 22,200 µg equiv STX di.HCl/Kg on 25th November both at st. P2 in Pontevedra.

2012. In the northern Ría de Ares-Betanzos, *A. minutum* bloomed from late April until the end of May (max. $26 \cdot 10^3$ cell·L⁻¹ in mid-May at St. L2). A maximum of 1220 µg equiv STX di.HCl/Kg-1 in mussels from the polygon Sada A was observed in mid May. Short-term closures affected harvesting of infaunal species in Ares and Camariñas. *A. minutum* (max. $8.2 \cdot 10^3$ cell·L⁻¹ in mid-May) led to harvesting closures in Baiona (Ria de Vigo) in April. Nevertheless, infaunal shellfish quarantine lasted almost until the end of the year, with maximal levels of 2,960 µg equiv STX di.HCl/Kg in mid-April.

Gymnodinium catenatum did not bloom in 2011. Cells were no longer present at the beginning of the year, but PSP toxins from the previous autumn outbreak kept toxins above regulatory levels until mid-January.

2013. *Alexandrium minutum* caused harvesting bans of raft mussels and infaunal shellfish in the inner parts of Ria de Ares-Betanzos (Rías Altas) in June, with maximum cell densities ($26 \cdot 10^3$ cell·L⁻¹, st. L2) and toxin levels (620 µg equiv STX di.HCl/Kg) in mid June in Sada. Much higher values (13,660 µg equiv STX di.HCl/Kg) were detected in infaunal species. In Ria de Camariñas there were two *A. minutum* events in July (max. $57 \cdot 10^3$ cell·L⁻¹ in early July and 7,400 µg equiv STX di.HCl/Kg in mussels one week later) and the second in September (max. $32 \cdot 10^3$ cell·L⁻¹ in mid-September and 3,160 µg equiv STX di.HCl/Kg the next week). In Ría de Cedeira, collection of infaunal shellfish was banned from mid-August to mid-November (max. 5194 cell · l⁻¹ on August 8 and 2880 µg equiv STX di.HCl/Kg on September 9).

Conclusions 2011–2013: Irregular blooms of *G. catenatum* occur only in the Galician Rías Baixas (south of Cape Finistere). Blooms were only recorded in 2011, but they were exceptional for their in situ development in summer (the normal situation is advected blooms during the upwelling autumn transition). *A. minutum* is the agent of very localized short-term PSP outbreaks affecting mussels close to small brackish embayments (Baiona in the southern mouth of Ria deVigo, and the northern Rías Altas) in late spring. Nevertheless, infaunal shellfish resources from these small embayments, sheltered from the upwelling circulation, present PSP toxins above regulatory levels for much longer periods (from May to October in 2011).

DSP

2011 *Dinophysis acuminata* bloomed in three separated pulses. From late April to late July caused harvesting closures (DSP) of raft mussels in the Northern (Ria de Ares) and Southern Rías (Muros, Pontevedra and outer reaches of Vigo and Arousa) and of infaunal molluscs in coastal areas north of Cape Finisterre. Maximal cell densities of *D. acuminata* ($4.7 \cdot 10^3$ cell·L⁻¹) co-occurring with *D. caudata* ($2.3 \cdot 10^3$ cell·L⁻¹) were found in late May at the hot spot (st. P2) in Ria de Pontevedra during the first pulse. A second, more intense bloom lasted from the end of August through September (max. $15.2 \cdot 10^3$ cell·L⁻¹ at st. P5 in Ria de Pontevedra, on 29th August), leading to closures of all Galician mussel production areas except small inlets in the Rías of Arousa and Vigo. They also caused harvesting bans of infaunal shellfish in the northern Rías and parts of the Southern Rías (Muros and inner areas of Arousa and Pontevedra. The last proliferation of *D. Acuminata*, in November-December, again caused closures in the Northern (R. Ares) and Southern (Muros, Pontevedra, outer reaches of Vigo and Arousa) Rías with a maximum of $1.5 \cdot 10^3$ cell·L⁻¹ in Ria de Pontevedra (st. P5) on 7th November. Overlapping of closures during the second and

third outbreak led to uninterrupted closures in Ria de Pontevedra from mid-August to late December.

2012. *D. acuminata* first bloom of the year was unusually early and intense, causing extensive raft-mussel harvesting bans in all the Southern Rías from late March until mid-August with the exception of the innermost parts of Arousa and Vigo. Record cell densities (up to $54 \cdot 10^3$ cell·L⁻¹) were found in Ria de Pontevedra. Harvesting closures included infaunal shellfish from both coastal waters and rías in the north, and some of the Southern Rías (Pontevedra, Muros-Noia).

New shellfish closures were enforced in several mussel-raft areas in Pontevedra (the whole Ría), Vigo, Muros-Noia and the Northern Rías associated with a moderate autumn peak of *Dinophysis* spp. (max. 760 cell·L⁻¹ of *D. acuminata* and 200·cell·L⁻¹ of *D. fortii* at st. 7 in Pontevedra). Short lasting bans also affected infaunal species in the north.

2013. *Dinophysis acuminata* bloomed in all mussel production areas in the Galician Rías Baixas from early April to the end of May (max. $8.7 \cdot 10^3$ cell·L⁻¹ on early April at st. P6 in Ria de Pontevedra) and from mid-July until the end of August (max. $12.2 \cdot 10^3$ cell·L⁻¹ at st. V1 in Ria de Vigo in late July) except in the innermost areas of Ria de Vigo. Harvesting bans affected also all infaunal shellfish from Vigo and Pontevedra in July and from the entire coast in August.

A downwelling event on the first week of October caused a massive advection of *D. acuta* and simultaneous shellfish harvesting bans in all raft-suspended and infaunal shellfish. These bans lasted a few weeks for infaunal species but until mid-December for raft mussels. Maximum densities of *D. acuta* ($11 \cdot 10^3$ cell·L⁻¹) and *D. acuminata* ($3.6 \cdot 10^3$ cell·L⁻¹) co-occurred on 14 October at st. P8 in Ría de Pontevedra.

Conclusion 2011–2013. These three years have been exceptionally intense in terms of length of the blooms and days of harvesting bans. 2011 because of 3 intense blooms of *D. acuminata* between spring and autumn; 2012 and 2013 because of unusually early blooms (first peak in late March-early April) of *D. acuminata* (associated with anomalous winter wind patterns) and the worst scenario in 2013 with the abrupt advection of *D. acuta* after months of harvesting bans caused by *D. acuminata*.

ASP

2011. A brief bloom of *Pseudo-nitzschia* cf. *australis* from late April to mid-May caused closures of raft mussels in parts of the Southern Rías - Baiona (Vigo), Muros (max. $6.5 \cdot 10^5$ cell·L⁻¹ and 58.5 ppm DA in late April at st. M1 in Muros), Pontevedra - and infaunal molluscs in all of them in addition to coastal areas (Viveiro, Celeiro, O Barqueiro, Corme, Corcubión-Finisterre) in the north.

Another short event of *P. cf. australis* in August caused mussel harvesting bans in the north (Corme, 129 ppm DA in late August) and in raft and infaunal molluscs in all Ría de Muros (max. $6 \cdot 10^5$ cell·L⁻¹). Finally, an episode of *Pseudo-nitzschia* spp. in October led to mussel harvesting closures in Rias of Muros (south) and Ares (north) (max. $2.8 \cdot 10^5$ cell·L⁻¹ and 22.2 ppm DA on 6th October). Precautionary closures were established for infaunal molluscs from Muros, O Burgo, Corcubión, Fisterra, but toxins did not exceed regulatory levels. Scallops (*Pecten maximus*) contained DA above regulatory levels (RL) all year

round. Restricted harvesting with evisceration was carried out according to EU Directive 2002/226/EC was implemented.

2012. *Pseudo-nitzschia cf. australis* bloomed in Baiona Estuary (Ría de Vigo) in early February (max. $1.5 \cdot 10^5$ cell·L⁻¹) and 2 weeks later in Ría de Pontevedra (max. $2.2 \cdot 10^5$ cell·L⁻¹ at P8, 59.1 ppm DA in Bueu) leading to harvesting bans in all production areas there. This outbreak affected also infaunal shellfish from Ría de Pontevedra and parts of Ría de Vigo (max. 63.9 ppm DA in clams from zone III of Pontevedra). Another light 2-weeks ASP outbreak affected mussel harvesting in the northern Ría de Ares-Betanzos in April (max. $2.1 \cdot 10^5$ cell·L⁻¹ st. L1; 40 ppm DA in Sada A) and led to brief closures of infaunal species in Ferrol, Ares, Corme y Camariñas. In early October a new bloom of *P. cf. australis* led to short-term mussel harvesting closures in the north (Ría de Ares-Betanzos) and part of the Rías Baixas (Muros-Noia) (max. $1.9 \cdot 10^5$ cell·L⁻¹ in st. M3 in Muros, 37.0 ppm in Noia A). Infaunal shellfish harvesting was enforced in the north (Cedeira, O Burgo-Coruña) and Zone-II in Pontevedra, with max. levels of 82.8 ppm DA in cockles from Pasaxe.

Restricted harvesting with evisceration of scallops with DA above RL year-round.

2013. In 2013 there were no mussels harvesting bans associated with blooms of *Pseudo-nitzschia* spp. Nevertheless there were brief (about one week) bans for infaunal shellfish in the Rías Baixas (Baiona Estuary, Ría de Vigo, max. $2.3 \cdot 10^5$ cell·L⁻¹ and 16.4 ppm DA) in early September and in the Rías Altas (Corcubión-Fisterra, max. $0.3 \cdot 10^5$ cell·L⁻¹ and 41.3 ppm DA in late May; Corme-Laxe, max. $1.4 \cdot 10^5$ cell·L⁻¹ and 33.3 ppm DA in mid-June) in late spring.

Scallops (*Pecten maximus*) contained DA above regulatory levels all year round, but restricted harvesting with evisceration (according to Directive 2002/226/EC) was carried out.

Conclusion 2011–2013: Usual harvesting bans of mussels (except in 2013) and infaunal resources, that are short lived and in restricted areas. The exception is with scallops (*P. maximus*) which are permanently with DA above RL and are commercialized, when possible, after evisceration (according to EU Directive 2002/226/EC).

CATALONIA (ES21–ES 23)

Sampling frequency of production areas in Catalonia by IRTA is weekly or biweekly depending on the site and time of the year. During 2013, the number of sampling stations was increased to have a better coverage of the whole Catalan coastline

PSP

2011. *Alexandrium minutum* reached alert levels in shellfish growing areas of the Ebro Delta and in the open coast in abundances of $2 \cdot 10^3$ cell·L⁻¹ but all samples analyzed by the AOAC method for PSP bioassay were below RL.

2012. *A. minutum* reached $5 \cdot 10^3$ cell·L⁻¹ in Alfacs Bay and over alert levels in other areas along the Catalan coast in March, but PSP toxins were below RL.

2013. Precautionary closure in Estarlit in May due to the presence of *A. minutum* ($15 \cdot 10^3$ cell·L⁻¹) over alert levels.

Conclusions 2011–2013: There were no PSP events despite frequent detection of *A. minutum* in concentrations above their established trigger level in that region.

DSP

2011. There was only one closure in the production area L'Escala-Roses-Cadaqués after detection of DSP/lipophilic toxins (EU Standard Operating Procedure SOP, 5) over RL in *Donax trunculus* in December; the causative species was not confirmed. *Dinophysis sacculus* and other *Dinophysis* species were present in low abundances in the Ebro delta bays reaching alert levels in May and at the end of the year.

2012. DSP producing species were present in different locations throughout the coast of Catalonia in different times of the year leading to harvesting closures in Alfacs and Fangar bays (Ebro Delta), and north of Vilanova and Roses. *D. sacculus* was over alert levels during 3 months in Alfacs Bay (max. $2 \cdot 10^3$ cells·L⁻¹), causing a long (January to mid-April) DSP closure, and in November-December in Fangar Bay. YTXs were detected in Alfacs Bay in July-August at concentrations below RL in shellfish associated with low densities of *Gonyaulax spinifera* and *Protoceratium reticulatum*, but in September, yessotoxins concentration in mussels (1340 µg eq. YTX·kg⁻¹) exceeded the RL according to LC-MS/MS analyses, although MBA results (applying the annex of SOP5 for lipophilic toxins) were negative for the same samples. *P. reticulatum* maximum ($1.4 \cdot 10^3$ cells·L⁻¹) detected in September. At the same time and after 3 weeks of seawater temperatures over 28°C, all mussels from Alfacs Bay died and closures enforcement was not necessary. YTXs concentration in other shellfish species kept below RL.

2013. Lipophilic toxin closures in Alfacs Bay in February and April related to the presence of yessotoxins over regulatory levels in mussel seeds imported from the Adriatic Sea, and in April in Fangar Bay. At the shellfish growing areas maximum abundances of *D. sacculus* and *D. caudata* were $1.1 \cdot 10^3$ cells·L⁻¹ and 800·cells·L⁻¹ respectively although higher densities were observed inside the harbors and marinas.

Conclusion 2011–2013: Long lasting (> 3 months) harvesting bans in 2012 on the Ebro Delta bays due to the main DSP agent in the region (*D. sacculus*) and discrepancies between LC-MS (> RL) and mouse bioassay (<RL) results in YTX analyses. Only one production area with DSPP in 2011 and no problems in 2013.

ASP

2011. *Pseudo-nitzschia* spp. present (max $5 \cdot 10^3$ cell L⁻¹) in October, but all results of shellfish samples analyzed for domoic acid were <LOQ.

2012. *Pseudo-nitzschia* spp. reached high abundances in the south ($6 \cdot 10^6$ cells L⁻¹). DA under RL detected in shellfish from the northern and middle areas of the Catalan coast in February and March.

2013. DA in shellfish under RL, although abundances of *Pseudo-nitzschia* spp. were over alert levels during 25 weeks (max. $3 \cdot 10^6$ cells·L⁻¹).

Conclusions 2011–2013: There were no ASP events in Catalonia despite frequent detection of *Pseudo-nitzschia* spp. in concentrations above the established trigger levels in that region.

Fish Killers

2011. No reports of *Karlodinium* spp or fish kills in 2011.

2012. *Karlodinium* spp. reached $1.4 \cdot 10^6$ cells·L⁻¹ in April in a bloom lasted from February to June in Alfacs Bay. Fish kills occurred associated with this event.

2013. Ichthyotoxic events were not observed. *Karlodinium* was under alert level; maximum density detected was $24 \cdot 10^3$ cells·L⁻¹.

Conclusions 2011–2013. No *Karlodinium* fish kill events except in 2012.

Cyclic Imines

2013. Non legislated cyclic imines were routinely monitored at IRTA this year. Low levels of 13-desmethyl-spirolide C and pinnatoxin G were detected, with a maximum of ~ 40 $\mu\text{g} \cdot \text{kg}^{-1}$ pinnatoxin G in clams.

Benthic HABs

2011. Dense blooms of *Ostreopsis* spp. in the hot spot of Sant Andreu de Llavaneres throughout the summer (end of June to early October) with a maximum of $9.6 \cdot 10^6$ cells L⁻¹ in the water column and $71 \cdot 10^6$ cells·g⁻¹ of macroalgae (wet weight, w.w.) in early July. The Catalan Water Agency (ACA) warned Council and health authorities; warning posters were displayed in the affected beaches; information was disseminated by the press. There were no reports of respiratory and skin irritations from the public in the exposed area.

2012. *Ostreopsis* spp. bloomed at Sant Andreu de Llavaneres during summer, reaching very high concentrations in water (up to $2 \cdot 10^5$ cell·L⁻¹) and macroalgae (up to $2 \cdot 10^6$ cells·g⁻¹ w.w. macroalga) in late July-early August. Coinciding with the highest concentrations of *Ostreopsis* spp. in late July, there was an outbreak of respiratory irritation affecting 13 people who were participating in a fishing cane contest. All contestants, aged between 20 and 50 years, showed mild symptoms of impairment and throat irritation: sore throat, dry cough, headache, sneezing, etc. The event was reported in the press media (El País, La Vanguardia, El Periódico, among others). The Catalan Water Agency (ACA) was contacted whenever *Ostreopsis* densities reached $\sim 10^5$ cells·g⁻¹ w.w. macroalgae or $\sim 10^4$ cells·L⁻¹ in seawater at Llavaneres. This is an empirically based threshold: at those concentrations health problems in humans may occur if the wind is blowing landwards.

2013. Maximum densities of $1.8 \cdot 10^5$ cell·L⁻¹ were found in early August in Llavaneres beach, and lower densities (10^3 cell L⁻¹) in beaches of Terramar (Sitges) and Sant Feliu, but there were no toxic aerosol events.

Conclusions 2011–2013: Epiphytic cells of *Ostreopsis* attached to macroalgae in rocky beaches are common in the Catalan coast, but can be found occasionally in high densities in the water column. The latter case, associated with winds blowing towards the coast has been associated with respiratory irritations (only in 2012 in this triennium).

High Biomass and Toxigenic HABs in beaches and ports.

2011. Dense blooms of *A. minutum* in different harbors with no shellfish exploitations (Estartit, Arenys de Mar, Vilanova y la Geltrú, Cambrils) with a max. of $5.4 \cdot 10^6$ cell L⁻¹ in Cambrils. Moderate to high densities of *Dinophysis sacculus* in Estartit, Arenys de Mar,

Port de Barcelona, Vilanova y la Geltrú and Tarragona harbors (max. $5.9 \cdot 10^4$ cell L^{-1}) and high densities ($\geq 5 \cdot 10^5$ cell L^{-1}) of *Pseudo-nitzschia* spp. in Arenys de Mar, Vilanova y la Geltrú, Port de Tarragona and l'Ametlla, as well as in several beaches throughout the Catalan coast. In June, a proliferation ($8.2 \cdot 10^4$ cell L^{-1}) of a raphidophyte (*Chattonella* sp.) was observed in the mouth of the Muga river.

2012. Local blooms of *A. minutum* detected in several ports: Arenys de Mar (max. $1.7 \cdot 10^6$ cell L^{-1}), Port Olímpic and Cambrils. Significant concentrations of *Dinophysis sacculus* ($2.5\text{--}3 \cdot 10^3$ cell L^{-1}) were also detected at two ports, Arenys de Mar and Vilanova i la Geltrú. A bloom of *Alexandrium catenella* ($1.4 \cdot 10^5$ cell L^{-1}) was recorded in July in Port de Tarragona. High concentrations ($\geq 5 \cdot 10^5$ cell L^{-1}) of *Pseudo-nitzschia* spp were detected in Port Olímpic, Port of Tarragona and beaches (Estartit and Castelldefels) in the northern and central coasts of Catalonia. Finally a proliferation (max. $3.8 \cdot 10^6$ cell L^{-1}) of a raphidophycean (*Fibrocapsa japonica*) occurred in Castelldefels and Viladecans in July.

2013. The most abundant potentially harmful microalgae observed in 22 sampled beaches were *Alexandrium taylori*, *Gymnodinium* spp. and *Ostreopsis* spp. Other HAB species detected in low densities were *A. minutum*, *A. tamarense*, *Prorocentrum lima*, *P. rhathymum*, *Pseudo-nitzschia* spp. and several species of *Dinophysis*. *A. taylori* was detected in all beaches sampled throughout the Costa Brava. This species produces high biomass blooms with negative effects in tourist resources every year. Densities above 10^6 cell L^{-1} were found in Estartit 3 (max. $1.5 \cdot 10^6$ cell L^{-1} in mid July), La Gola and El Grau beaches. *A. taylori* usually occurs with other bloom forming *Gymnodinium* spp., such as *G. litoralis* and *G. instriatum* (max. $2 \cdot 10^6$ cell L^{-1} in Grau Beach by mid July). *G. impudicum* forms recurrent high biomass noxious blooms (bad smell, mucilage, water discoloration) in several sport harbours, in particular in that of Tarragona (max. $7.3 \cdot 10^4$ cell L^{-1} in El Prats beach in late August). *Gonyaulax fragilis* occurrence from Cape Salou to the Ebro Delta coincided with the detection of mucilaginous filaments and patches by the Catalan Water Agency (ACA). Samples from this mucilage from Cala Sirenes (Mont-Roig) and La Llosa (Cambrils) collected on 23 July showed densities $> 10^6$ cell L^{-1} of this species during an event similar to a previous one described in 2006 in the same area.

Conclusions 2011–2013: High biomass blooms of *A. taylori* and *A. minutum* causing water discoloration (visual pollution) and of *G. impudicum* and *G. fragilis* generating mucilage, foams and bad smells are common in ports with restricted circulation and beaches in the Catalan coast representing a nuisance for the tourist industry.

Basque Country (ES01)

DSP, ASP and PSP

Analyses of DSP, ASP and PSP toxins are conducted in wild mussels and oysters collected, once a week, from October to December in the Butrón estuary and from October to March in the Oka estuary. This monitoring strategy coincides with the sites and seasons allowed by the local authorities for shellfish harvesting activities. The biotoxins were below the detection limits in all the samples during the 3 years.

Conclusions 2011–2013. No shellfish toxins above regulatory levels have been detected during the restricted time and space of monitoring (Oct to Dec in one estuary and Oct to March in another).

In addition, phytoplankton species composition and abundance are analysed every year at 3 offshore stations, 16 coastal stations and 32 estuarine stations as part of the Littoral Water Quality Monitoring and Control Network of the Basque Country, conducted by AZTI-Tecnalia for the Basque Water Agency (URA). Samples are collected during four campaigns (spring, summer, autumn and winter), in surface waters (0–1 m). Several potentially harmful phytoplankton taxa have been observed in the marine and estuarine stations but no apparent damage was reported.

- At the offshore stations: *Pseudo-nitzschia* spp., *Prorocentrum minimum*, *Alexandrium* sp., *Dinophysis acuminata*, *D. acuta*, *D. caudata*, *D. tripos* and *Phalacroma rotundatum*; *Karenia* cf. *mikimotoi*, *Chrysochromulina/Imantonia/Phaeocystis*
- In the coastal zone: *Alexandrium* spp, *Karenia* cf. *mikimotoi*, *Pseudo-nitzschia* spp., *Prorocentrum minimum*, *Dinophysis acuminata*, *D. tripos*, *D. cf. ovum* and *Phalacroma rotundatum*; *Phaeocystis globosa* and *Chrysochromulina/Imantonia/Phaeocystis*.
- In estuaries: *Pseudo-nitzschia* spp., *Pfiesteria* sp, *Prorocentrum minimum*, *Alexandrium* spp., *Dinophysis acuminata* (spring); *Chrysochromulina* spp., *Heterosigma akashiwo* and *Kryptoperidinium foliaceum*, *Urgorri complanatus* and *Heterosigma akashiwo*

Canary Islands

Ciguatera

2011. On 26 June 2011, the Food Safety Department of the Canary Island Government reported five cases (members of the same family) of ciguatera poisoning after recreational fishing and consumption of “medregal”, a large carnivore (*Seriola rivoliana*) caught at Fuerteventura coast. On 29th September, a 29.3-kg *Seriola rivoliana* specimen was tested positive after using a commercial ciguatoxin kit (IUSA); this was verified by the European Community Laboratory of Marine Biotoxines in Vigo, Spain.

2012. On 27 April, the Food Safety Department of the Canary Islands Government (Dirección General de Salud Pública) reported sixteen cases of ciguatera fish poisoning in Lanzarote. The first outbreak was between 28th January and 28th February and ten persons were affected by consumption of medregal (*Seriola rivoliana*) served in two local restaurants. The second outbreak was in April and affected six persons after eating the same fish at the same local restaurant. This information was reported by the local press in April and generated public alarm. After these outbreaks and subsequent public concern, the local authorities prohibited the consumption of *Seriola rivoliana* specimens larger than 55 kg, and created awareness within the population about the need to get large fish analysed by the Food Safety Department to prevent new intoxications.

2013. A new outbreak reported from Lanzarote in early December and first known from the press media. Ten people affected after eating a large *Seriola* bought in a fishmonger.

Conclusions 2011–2013: There has been cases of Ciguatera Fish Poisoning the 3 years after eating large (>15 kg) *S. rivoliana* specimens. This is a quite recent problem for the region. The only regulation enforced is the prohibition to consume fishes larger than 15 kg in the case of *S. rivoliana* (weight varies with other species). Specimens above the legal weight have to be deep-frozen and wait for analytical results.

Cyanobacteria

2011. Between May and November, *Lyngbya majuscula*, a benthic filamentous toxigenic cyanobacteria, formed a bloom covering hundreds of km² at depths from 2 to 30 m on the eastern coast of Fuerteventura Island. There was not any damage reported. This is the first record of this type of bloom in the Canarias archipelago.

4.10 Sweden National Report 2011–2013

Bengt Karlson

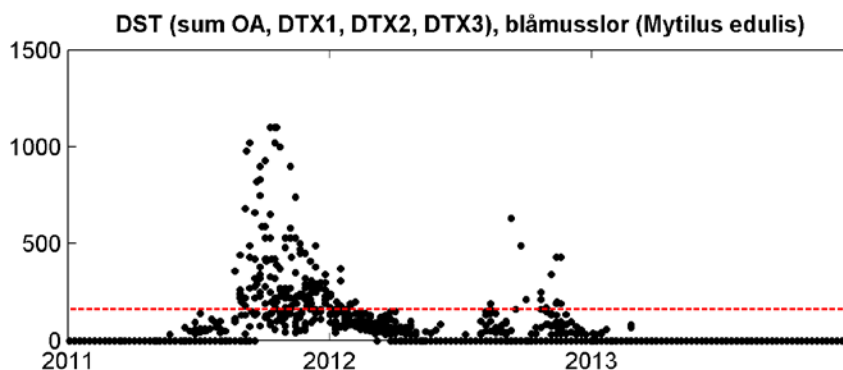
Background

Harmful Algal Blooms (HAB's) are recurrent phenomena in the waters surrounding Sweden. Most are likely to be of natural origin. The HAB-problems for the waters surrounding Sweden are very different for the Baltic Sea and the Skagerrak-Kattegat areas. In the brackish water of the Baltic Sea blooms of cyanobacteria, e.g. the toxic species *Nodularia spumigena*, is the major problem while in the waters with higher salinities in the Skagerrak and the Kattegat fish killing species and species that produce toxins that accumulate in filter feeders (e.g. mussels) is the major concern. However, both fish killing species and species causing shellfish poisoning occur in the Baltic Sea as well. Commercial farming and harvesting of wild mussels and oysters for human consumption is ongoing only along the Swedish coast of the Skagerrak at present.

The Skagerrak and the Kattegat

Summary 2011–2013

No major harmful algal blooms occurred in years 2011–2013 in the Skagerrak and the Kattegat. In autumn year 2011 concentrations of diarrhetic shellfish toxins were high in blue mussels in some areas along the Swedish Skagerrak coast. At the same time mussels were collected with low DST-concentrations in other locations in the same general area.



Diarrhetic Shellfish Toxins in blue mussels (*Mytilus edulis*) commercially harvested along the Swedish west coast in years 2011–2013. Data from the Swedish National Food Agency. Note the large variability between years.

2011 The Skagerrak and the Kattegat

Commercial harvesting of shellfish is only carried out along the Skagerrak coast. Analysis of algal toxins in shellfish were made using chemical methods only from 1 July 2011. During the first six months both mouse bioassays and chemical methods were used.

In oysters (*Ostrea edulis*) and cockles (*Cerastoderma edule*) concentrations of algal toxins above the regulatory level were not detected. Results regarding blue mussels (*Mytilus edulis*) are found below)

DST

Concentrations of Diarrhetic Shellfish Toxins (DST) above the regulatory limit were detected from late August to end of year in blue mussels collected at the Swedish Skagerrak coast (Fig. 1) causing closures of harvesting of wild and farmed mussels in some areas. This coincided with a return of high abundances of *Dinophysis acuta*. DST levels have been low 2007–2010 when the *D. acuta* abundances were low.

PST, AST, and AZT

Concentrations of Paralytic Shellfish Toxins (PST), Amnesic Shellfish Toxins (AST) and Azaspiracidic Shellfish Toxins (AZT) above the regulatory limit were not detected. *Alexandrium* spp. were observed in the area on several occasions.

YTX

Yessotoxins (YTX) above the regulatory limit were detected in blue mussels in a few samples in May and June.

Fish killing algae

Pseudochattonella farcimen were observed along the Kattegat coast in March and April but no harmful effects were observed. *Chrysochromulina* sp. was found in bloom concentrations in May–June in the Sound, the Kattegat and in the Skagerrak but no harmful effects were observed. *Heterosigma* sp. was observed in the Sound and also *Karlodinium veneficum* but no harmful effects were detected.

Unusual bloom of *Ceratium* spp.

In November–December 2011 brown water was observed along the Swedish West coast at several locations. High biomass blooms this late in the growing season are unusual. In the Kungsbacka fjord, South of Gothenburg the chl. *a.* concentration was approximately 80 µg L⁻¹ which is extremely high for the area. Microscope analysis of water samples revealed that *Ceratium fusus*, *C. furca* and *C. tripos* were the dominant organisms. No harmful effects were observed.

2012 The Skagerrak and the Kattegat

The fish killing species *Fibrocapsa japonica* Toriumi & Takano, 1973, was reported from the Swedish west coast for the first time. No harmful effects of *F. japonica* were reported. Closures of harvesting of shellfish (mainly blue mussels, *Mytilus edulis*) due to accumulation of algal toxins occurred on the Skagerrak coast but not for long periods. The main reason was levels of Diarrhetic Shellfish Toxins above the regulatory level in some areas. The first period of closures was in January to February and the second in August to November. During these periods it was possible to harvest shellfish in some areas. In March 2012 chemical analysis indicated Paralytic Shellfish Toxins (PST) in blue mussels on one occasion. Presence of *Alexandrium* resulted in closures in March and May.

The dinoflagellate *Karenia mikotoi*, which may cause fish mortalities and mortalities of filter feeders, was observed in August in the Kattegat-Skagerrak front near Skagen. Vertical profiles of chlorophyll fluorescence showed peaks at 30–45 m depth. Water samples collected from these depths had abundances of *K. mikimotoi* of approximately 300 cells L⁻¹. No harmful effects were reported.

Abundances of algae producing toxins accumulating in shellfish were below the warning level most of the time. *Alexandrium pseudogonyaulax* was observed in July and August. Maximum abundance was 5000 cells per Litre. Although this species is on the IOC HAB checklist it has not been shown to be toxic in the Kattegat-Skagerrak area. *Dinophysis* was observed in abundances above the warning level in August. At this time DST in blue mussels was above the regulatory level in some cases. The species of interest are mainly *Alexandrium* spp. (Paralytic Shellfish Toxin, PST-producers), *Dinophysis* spp. (Diarrhetic Shellfish Toxin, DST producers), *Protoceratium reticulatum* (Yessotoxin, YTX producer), *Azadinium spinosum* (Azaspiracidic Shellfish Poisoning, AZT-producer) and *Pseudo-nitzschia* spp. (Amnesic Shellfish Toxins, AST producers).

In blue mussels DST was observed above the regulatory level in a few samples in January–February and in September to November. In one sample in March LC-MS screening for PST indicated presence of PST in blue mussels. AZT and AST were not recorded at levels above the regulatory limits in blue mussels (*Mytilus edulis*), oysters (*Ostrea edule*) or in cockles (*Cerastoderma edule*).

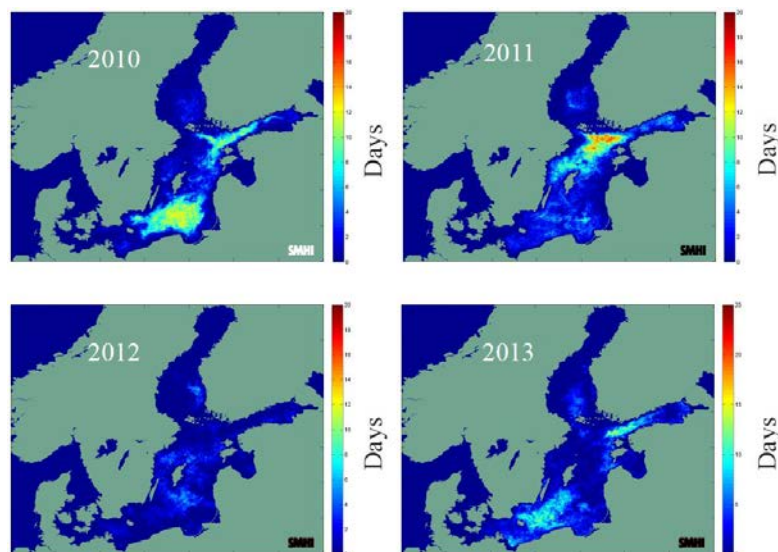
2013 The Kattegat and the Skagerrak

Concentrations of DST, PST, AST, yessotoxins and pectenotoxins in blue mussels, cockles and oysters were below the regulatory limit during the whole year. Potentially harmful genera such as *Alexandrium*, *Dinophysis*, *Pseudo-nitzschia* and *Chrysochromulina* were observed but in low cell numbers.

The Baltic Sea

Summary 2011–2013

Surface accumulations of cyanobacteria were observed mainly in 2011 and 2013 in the Baltic proper and in the Bothnian Sea. The species causing the surface accumulations were *Aphanizomenon* sp., *Nodularia spumigena* (toxic) and *Dolichospermum* sp. (syn. *Anabaena* sp.). Mortalities of dogs were reported in 2013. Coastal blooms of cyanobacteria were reported in summer and in autumn.



Number of days with satellite observations of surface accumulations of cyanobacteria in the Baltic Sea. The colour scale is from 0 to 25 days. Öberg, J. 2013. Cyanobacterial blooms in the Baltic Sea in the earlier years. Baltic Sea Environment Fact Sheet 2013. <http://helcom.fi/baltic-sea-trends/environment-fact-sheets/eutrophication/cyanobacterial-blooms-in-the-baltic-sea/>

2011

The Baltic proper

In May and also later in the year *Chrysochromulina* spp. was found in high abundances but no harmful effects were observed. The cyanobacteria bloom was unusually long with a start in late June and end in the beginning of September. The intensity was moderate and the bloom was mostly off shore. In July the toxic species *Nodularia spumigena* was common. The non-toxic species *Aphanizomenon flos-aquae* was dominating during a cruise in late July and is likely to have been the most important component of the surface accumulations forming nuisance blooms.

The Gulf of Bothnia

In late June there was a report of a bloom of the cyanobacteria *Anabaena lemmermannii*, in the Ostrnäs fjärden near the town of Umeå. *Nodularia spumigena* was a small part of the total biomass. The bloom continued all summer in this shallow and protected area. In the Bothnian Sea cyanobacteria blooms along the coast were reported in the end of July. In

August also off shore blooms were observed in the Bothnian Sea. Source of information: The information Centre for the Gulf of Bothnia.

2012

The Baltic proper

In general few observations of HAB's were made in 2012. On 8 July 2012 the first satellite observations of surface accumulations of cyanobacteria were made in the southern part of the Baltic proper. Strong winds and overcast weather is likely to be the cause of that no observations of strong surface accumulations were made until 25 July. From then until mid-August several observations of surface scums of cyanobacteria were made. Very few accumulations reached the Swedish coast. Strong winds probably mixed the cyanobacteria deeper into the water column. In autumn local surface accumulations of cyanobacteria were observed in some bays on the Swedish coast.

The Bothnian bay and the Bothnian Sea

Local algal blooms visible as surface accumulations of algae were reported along the Swedish coast from 1 July to early November. The autumn blooms often caused discoloration on beaches resembling spilled paint. Species and genera include *Nodularia spumigena* (producing the toxin nodularin), *Dolichospermum* spp. (synonym *Anabaena* spp.) and *Aphanizomenon*. Satellite observations of the off shore areas of the Bothnian Sea indicated surface scums of cyanobacteria mainly on the Finnish side in August 2012.

2013

The Baltic proper

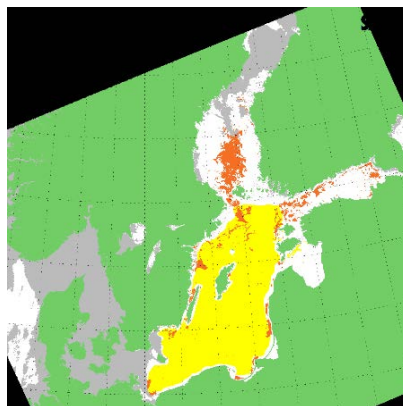
Surface accumulations of cyanobacteria were observed in the southern Baltic proper and at the mouth of the Gulf of Finland. The cyanobacteria bloom started unusually early. Surface accumulations were observed already on 19 June. Three mortalities of dogs were reported.



Cyanobacteria 13 July, 2013 at the coast of Kåseberga, Scania, southern Sweden. The megalithic monument Ale stenar, is visible on land. Photo by the Swedish Coast Guard.

The Bothnian Bay and the Bothnian Sea

In August 2013 surface accumulations of cyanobacteria were observed in the Bothnian Sea. Coastal blooms were reported both in summer and in autumn.



Distribution of cyanobacteria bloom on 3 August 2013. Note the surface bloom in the Bothnian Sea. Orange denotes surface accumulation while yellow denotes blooms deeper in the water. From the Baltic Algae Watch System www.smhi.se.

4.11 UK National Report 2011–2013

Eileen Bresnan

Closures of shellfish harvesting areas as a result of concentrations of algal toxins greater than the EU regulation limit were enforced every year between 2011 and 2013. There was a regional aspect to the distribution of these events with Scotland and the south of England having the most closures enforced. The toxins responsible for diarrhetic shellfish poisoning (DSP) and paralytic shellfish poisoning (PSP) were the main causes of shellfish harvesting closures. For the first time in 2012, closures for high concentrations of azaspiracid were recorded in UK shellfish.

PSP

2011: High cell densities of *Alexandrium* were observed at selected sites in England (~300,000 cells L⁻¹) and Scotland (>1,000 cells L⁻¹). Cell densities were low in Northern Ireland (<100 cells L⁻¹). Closures of shellfish harvesting areas were enforced at two sites on the west coast of Scotland during this period.

2012: *Alexandrium* cells were observed in high abundance (>1,000 cells L⁻¹) at selected sites in Scotland. Shellfish harvesting closures were enforced in three areas as a result of high concentrations of PSP toxins (the Clyde, Donorch Firth, Isle of Harris). *Alexandrium* cell densities were low (<100 cells L⁻¹) in Northern Ireland and there were no closures as a result of PSP toxins. In England, the highest cell density of *Alexandrium* cells was 25 X 10⁶ cells L⁻¹ but this bloom was not associated with any PSP shellfish toxicity.

2013: Closures owing to high concentrations of PSP toxins in shellfish were enforced in Scottish waters on the east and west coasts, Orkney and Shetland. Two closures were enforced on the south coast of England. No closures were enforced in Northern Ireland or Wales.

DSP and other lipophilic shellfish toxins

2011: *Dinophysis* cells were recorded around the UK coast during 2011. Closures as a result of the toxins responsible for DSP were enforced around the Scottish coast, in Northern Ireland, South Wales and Suffolk.

For the first time concentrations of the toxin azaspiracid (AZA) were recorded above the EU closure limit in the Western Isles and Shetland and high concentrations of Yessotoxins (YTX) were recorded in Loch Fyne in Scotland.

2012: *Dinophysis* was observed in Scottish shellfish throughout the summer months and closures of shellfish harvesting areas were enforced on the West and East coasts and the Western and Shetland Isles. No closures as a result of high concentrations of DSP toxins were enforced in England, Wales or Northern Ireland during the year. High concentrations of YTX were recorded in shellfish from the South West of Scotland and from the Shetland Isles.

2013: High cell densities of *Dinophysis* were observed around the Scottish coast during the summer months and widespread closures of shellfish harvesting areas were enforced along the West coast, Shetland, Western Isles and Shetland. Some closures were enforced for extended periods of time. Only two sites were closed in the South of England. No closures were enforced in Northern Ireland

ASP

2011: High cell densities of the diatom *Pseudo-nitzschia* were observed around the UK coast during 2011. No closures of shellfish harvesting areas as a result of high concentrations of domoic acid were enforced during the year.

2012: High cell densities of *Pseudo-nitzschia* were observed around the Scottish coast during 2012. Only one closure of shellfish harvesting areas was enforced during the year in Loch Spelve on the West Coast. High concentrations of *Pseudo-nitzschia* in Belfast Lough during the summer were associated with concentrations of ASP toxins in shellfish from this area resulting in a closure of harvesting activities. There were no closures in England or Wales as a result of ASP toxins.

2013: High concentrations of *Pseudo-nitzschia* were observed around the Scottish coast during the year. Only one shellfish harvesting area on the west coast was closed during the year. No closures were enforced in England, Wales or Northern Ireland.

Other

A large foam in the Footdee area in Aberdeen caused distress to residents in Sept 2012. This foam was associated with a severe storm and was present for 24 hours. No *Phaeocystis* blooms were associated with this incident.

4.12 US National Report 2011–2013

Don Anderson

New England (Regions 1–6)

PSP

2011. “Normal” closures due to PSP were experienced during this period, including eastern Maine, western Maine, New Hampshire and Massachusetts to the south shore.

2012. “Normal” closures due to PSP – including eastern Maine, western Maine, New Hampshire and the south shore of Massachusetts. There were no closures along the north shore of Massachusetts.

Combined research efforts by scientists involved in the Gulf of Maine Toxicity (GOMTOX) project, funded by NOAA, led to enhanced understanding of *Alexandrium* blooms on Georges Bank. This new information, coupled with an at-sea and dockside testing protocol developed through collaboration between GOMTOX and U.S. Food and Drug Administration (FDA) investigators, has allowed fishermen to harvest ocean quahogs and surf clams in these offshore waters for the first time in more than two decades. The shellfish industry estimates the Georges Bank fishery can produce up to 1 million bushels of surf clams and ocean quahogs a year, valued \$10 – 15 million annually.

2013. New England experienced very low PSP toxicity. No closures were instituted in Massachusetts or New Hampshire. Regional mussel closures covering the entire state (except certain specified areas) were instituted for the first time in Maine due to budget and staffing pressures. Maine is also moving away from the mouse bioassay to HPLC.

Conclusion 2011–2013: New England experienced relatively low levels of toxicity during this period. 2013 was exceptionally low with toxicity restricted to a few locations in Maine. A major commercial breakthrough was the opening of shellfish harvesting in the offshore waters of Georges Bank after closures for more than 23 years.

ASP

2011. No domoic acid detected in Maine.

2012. Domoic acid was detected in shellfish east of Mount Desert Island, Maine, and, subsequently, the first-ever closure for ASP in Maine was issued in late summer. Domoic acid levels in the initial samples screened with Jellett Rapid Tests that were the basis of the closure decisions were later found to be below the quarantine threshold and thus the closure was withdrawn.

2013. No ASP closures occurred in Maine, although toxin was detected at low levels (below quarantine) in plankton samples.

Conclusion 2011–2013: ASP appears to be an emerging issue for Maine and perhaps for other Gulf of Maine states – the first-ever closure occurred in 2012, though toxin levels were low.

New York (Long Island; Region 8)**PSP**

2011. Closures occurred on the north side of Long Island (Northport Bay, Huntington Bay and Lloyd harbor) as well as all of Shinnecock Bay on the south side of the island.

2012. Closures occurred on the north side of eastern Long Island (Mattituck Creek / Mattituck Inlet). It was noted that this closure occurred approximately one month earlier than previous years. The winter was also significantly warmer than previous years. This year was a record for acres of shellfish beds closed due to PSP toxins.

2013. Brief closures occurred in western and eastern portions of Long Island.

Conclusion 2011–2013: Brief closures occurred every year in the “normal” locations for this area in recent times, though in years past, the eastern part of Long Island has not had any closures. 2012 was a record in terms of the early bloom and the area of shellfish beds closed.

DSP

2011. No DSP incidents or closures.

2012. Relatively high levels of DSP toxins (16.5 - 140 µg / 100 g shellfish) were measured on the north side of Long Island.

2013. DSP toxins levels (20 µg / 100 g shellfish) were reported on the north shore of Long Island, but these were in areas that were already closed for shellfish closing.

Conclusion 2011–2013: DSP appears to be an emerging threat in this area as with other locations in the US.

Brown tide

2011. The south shore of Long Island experienced a significant brown tide bloom (*Aureococcus anophagefferens*), which began in June and ended in July. The bloom was very intense compared to prior years, reaching densities over two million cells per ml (normally blooms peak at one million cells per ml).

2012. The south shore of Long Island experienced a significant brown tide bloom, which began in May and ended in July. The *Aureococcus* bloom was very intense, similar to 2011, reaching densities over two million cells per ml.

2013. The south shore experienced a significant *Aureococcus* brown tide bloom, which began in May and ended in November.

Conclusion 2011–2013: The area experienced significant brown tides during this period, with 2013 being the seventh year in a row with elevated *Aureococcus* concentrations, following a decade of very low levels. Before that, there was a decade of high concentrations, beginning in 1987.

Cochlodinium

2011. Eastern Long Island experienced a large *Cochlodinium polykrikoides* bloom, causing mortalities in caged fish and shellfish.

2012. Eastern Long Island experienced a *Cochlodinium* bloom.

2013. Peconic Estuary and Shinnecock Bay experienced a large (10,000 cells/L) *Cochlodinium* bloom in the fall, causing fish kills.

Conclusion 2011–2013: *Cochlodinium* has caused problems for eastern Long Island since 2004. It is a persistent “red tide” former throughout the Long Island region, as well as in Buzzards Bay and other areas of southeastern Massachusetts, although fish kills have not been reported in those regions.

Florida (Regions 15–16):

NSP

2011. *Karenia brevis* blooms occurred on both the east and west coasts of Florida. Both blooms started in the fall and continued through the end of the year. Fish kills (multiple species) were attributed to the *Karenia* bloom on the west coast, and respiratory problems in humans were also reported.

2012. *Karenia brevis* blooms occurred on the Florida west coast. The 2011 bloom continued into 2012 (through 12 March) and the 2012 bloom began 17 September and continued into 2013. Fish kills (multiple species) were attributed to the *Karenia* bloom, and respiratory problems in humans were also reported.

2013. *Karenia brevis* blooms occurred on the west coast. Fish kills (multiple species) were attributed to the *Karenia* bloom, and respiratory problems in humans were also reported.

Conclusion 2011–2013: As has been the case for many, many years, Florida experienced problems with *Karenia* blooms every year on the west coast, and in 2011 on the east coast.

PSP

2011. *Pyrodinium bahamense* blooms occurred on the Florida west coast (Tampa Bay). The bloom lasted approximately 2 months but did not reach the lower levels of the Bay where shellfish harvesting is permitted. The maximum cell concentration was 600,000 cells/L. The Indian River Lagoon bloom (east coast) lasted for approximately 5.5 months with a maximum cell count of just under 1 million cells/L.

2012. No reports of *Pyrodinium bahamense* blooms this year.

2013. Both the west coast of Florida (Tampa Bay) and the east coast (Indian River Lagoon System) experienced PSP attributed to *Pyrodinium bahamense*. No human illnesses were reported.

Conclusion 2011–2013: *Pyrodinium bahamense* has been a recurring issue in the Indian River Lagoon (east coast) and the Tampa Bay area (west coast) over the past decade. Before that, PSP toxicity was not known to be a problem in Florida.

Brown tide

2011. No occurrences this year.

2012. The Indian River and Mosquito Lagoons (east coast) experienced brown tide, due to *Aureoumbra lagunensis*, from mid-July to early October. There were many impacts to benthic and planktonic ecosystems. This was the first known major outbreak of brown tide in Florida.

2013. The Indian River Lagoon experienced brown tide from early April to mid-November, due to *Aureoumbra lagunensis*. It is also of note that during the summer, a dense *Aureoumbra* brown tide occurred in Guantanamo Bay, Cuba at the US naval base, causing significant problems to the desalination facilities that provide all of the fresh water for the base.

Conclusion 2011–2013: *Aureoumbra* brown tides could be an emerging problem in this area, with occurrences in two of the past three years and an apparent dispersal to Cuba.

ASP

2011. No reports.

2012. No reports.

2013. For the first time, Florida experienced a closure due to domoic acid. This was due to a short-lived *Pseudo-nitzschia* bloom in the Florida panhandle (Gulf coast) with levels reaching 76 µg DA/g shellfish in *Crassostrea virginica* (oysters).

Conclusion 2011–2013: ASP may be an emerging problem for Florida with the first ever closure due to DA occurring in 2013 in the Panhandle.

Texas (Region 18)

NSP

2011. A bloom of *Karenia brevis* was initially detected in the Corpus Christi region by the Imaging FlowCytobot in July; the bloom continued into 2012. Mortalities included coyotes, domestic dogs, redhead ducks, shovelers, red knots, double-crested cormorants, fish and ghost shrimp. At one point during the bloom, discolored water and dead fish could be found along over 250 miles of Gulf beach, from San Luis Pass to the Rio Grande. Presumably this bloom extended into Mexico though we have no information to confirm this.

2012. A bloom of *Karenia brevis* occurred in the Corpus Christi region during the summer with fish kills reported.

2013. A brief bloom of *Karenia brevis* occurred in late August through mid-September in the Corpus Christi region. This bloom was initially detected by the Imaging Flow Cytobot at Texas A&M University.

Conclusion 2011–2013: *Karenia* blooms occurred every year during this period with animal mortalities in 2011 and fish kills in 2011 and 2013.

Brown tide

2011. No brown tide.

2012. No brown tide.

2013. For the first time since 2005, a brown tide, attributed to *Aureombra lagunensis* occurred in Baffin Bay and Upper Lagune Madre.

Conclusion 2011–2013: No brown tides were reported until 2013. Prior to 2013, a minor bloom occurred in 2005, the first recurrence since the major blooms throughout the 1990s.

California (Regions 19–21)**PSP**

2011. *Alexandrium* was observed at multiple sites along the California coast during all months of the year. There was a higher frequency of occurrence between January and April and again between August and December. The magnitude of PSP toxicity was slightly higher in 2011 than 2010 but below normal in terms of maximum concentrations detected. The highest score was 255 µg / 100 g shellfish in northern California and 220 µg / 100 g in southern California. The annual mussel quarantine, normally from 1 May through 31 October, began one month early due to increasing PSP and DA activity.

2012. The highest percent composition and frequency of occurrence for *Alexandrium* occurred between September and December. The magnitude of PSP toxicity was significantly greater in 2012 compared to 2011. There was a return to the pattern of PSP toxin distribution being confined to central and northern California sites. The highest levels were detected in mussels from the northern coastal counties of Humboldt and Del Norte. The highest PSP toxin concentration (6394 µg / 100 g) in 2012 occurred in mussels from Del Norte County, approximately 27 miles from the Oregon border. This was the highest concentration on record for this County. The timing of PSP activity in 2012 was also unusual, occurring in late fall and through January 2013. The 1 May through 31 October annual mussel quarantine was extended for these two northern California counties and was later expanded to include all bivalve shellfish in Del Norte.

2013. The highest percent composition and frequency of occurrence for *Alexandrium* was in December at two disparate locations: Tomales Bay ~50 miles north of the Golden Gate; and at Fish Harbor in Los Angeles County. Commercial harvest closures were implemented in the former location and health advisories for recreational harvest were issued for each area. Low levels of the PSP toxins were detected each month of 2013 in the northern California counties of Humboldt and Del Norte County. Dangerous levels of toxins occurred in these counties in January, a continuation of the 2012 event, and in August. The highest PSP toxin concentrations were detected in mussels from Humboldt, Del Norte, and Marin counties. The highest PSP toxin concentration occurred in the viscera of rock scallops (3926 µg / 100 g, Humboldt County) and in mussels from Del Norte County (2055 µg / 100 g). The May 1 through October 31 annual mussel quarantine was extended for a portion of Humboldt County.

Conclusion 2011–2013: California experienced relatively low PSP toxicity in 2011, but significant toxicity in late fall through winter of 2012 and 2013. The unusual occurrence

of dangerous toxin levels in the fall and winter months the past two years, outside of the normal quarantine period, is a significant concern.

ASP

2011. The highest relative abundance for *Pseudo-nitzschia* occurred in three distinct intervals during 2011: between late January and early April, between late May and August, and to a lesser extent between mid-October and November. The geographic distribution and magnitude of domoic acid toxicity in 2011 was less than observed in 2010. The temporal distribution of domoic acid was somewhat the reverse of the previous year, with a strong spring event and subsequent second event during the summer months. The highest domoic acid concentrations detected were: 387 µg/g and 265 µg/g in oysters and mussels, respectively, from Santa Barbara; and 413 µg/g in lobster viscera (“tomalley”) from the Channel Islands.

2012. The geographic distribution and magnitude of domoic acid toxicity in 2012 was less than observed in 2011. The temporal distribution of domoic acid was somewhat different than the prior year, lacking a strong spring event but exhibiting a summer period of toxicity. The California Department of Public Health issued a Health Advisory on August 20 for Ventura County that warned consumers not to eat recreationally harvested mussels and clams, commercially or recreationally caught anchovy and sardines, or the internal organs of commercially or recreationally caught crab (“crab butter”) and lobster (“tomalley”). A second health advisory identical in scope to the Ventura warning was issued on September 14 for the northern Channel Islands.

2013. High relative abundances of *Pseudo-nitzschia* were also observed at sites between Marin and Los Angeles counties. The magnitude of domoic acid toxicity in 2013 was less than observed in 2012, with moderate toxin levels occurring in both the spring and fall months at various locations. The highest concentrations were detected in rock crab viscera from the offshore Channel Islands. The maximum concentration was 360 µg/g.

Conclusion 2011–2013: Declining ASP toxicity occurred during the 3-year period; Persistent toxicity occurred in rock crab viscera from the offshore Channel Islands, at times in the absence of significant *Pseudo-nitzschia* densities, suggesting either slow depuration rates or a reservoir of toxin in the crabs’ food sources.

DSP

2011. No reports of DSP.

2012. No reports of DSP.

2013. *Dinophysis* spp. were present in San Luis Obispo and Santa Barbara counties during May in slightly higher abundances than observed in past years. As a precaution, samples of mussels, phytoplankton (net tow and composite whole water), and rock crab were sent to the FDA Dauphin Island lab for analysis. They reported the following: Dinophysistoxin-1 (DTX-1) and okadaic acid were detected in all three mussel samples, net tow, and composite seawater samples provided. In all cases toxin levels were below the FDA guidance level for total OA equivalents (free OA, DTX-1, DTX-2 + acyl esters) of 0.16

ppm. The highest concentration detected was 0.04 ppm total OA equivalents in a mussel sample from Santa Barbara.

Conclusion 2011–2013: DSP may be an emerging problem for this area, but at this point, levels have not approached quarantine level.

Oregon (Region 22)

PSP

2011. This was a relatively light year for PSP toxicity in Oregon, reaching 230 µg / 100 g shellfish.

2012. PSP toxicity reached 1,740 µg / 100 g shellfish at Gold Border (near the California border) in late October.

2013. PSP toxicity reached 1,50 µg / 100 g shellfish, with the highest toxicity recorded near the California border.

Conclusion 2011–2013: Oregon experienced low levels of PSP toxicity in 2011, but high in 2012 and 2013.

Washington (Regions 23–24)

PSP

2011. Compared with 2010, Washington had a low PSP year with no site exceeding 1000 µg / 100 g shellfish. Closures took place in Puget Sound, the Strait of Juan de Fuca and the Olympic Peninsula. An automatic annual shellfish closure is put in place between April and October 31 for the outer Washington coast.

2012. PSP toxin levels were much higher in Washington state in than in 2011, with the highest recorded value being 10,304 µg / 100 g shellfish detected in mussels near Kingston (Puget Sound). Nine confirmed cases of PSP in humans were reported, which is very unusual.

2013. The highest toxin level recorded was 8,040 µg / 100 g shellfish detected in mussels in South Puget Sound. No human illnesses were reported.

Conclusion 2011–2013: 2012 was unusual in terms of the toxin levels and human PSP cases. 2013 also saw high toxin levels, but no illnesses.

ASP

2011. Washington reported very low levels of domoic acid with no closures.

2012. Washington reported very low levels of domoic acid with no closures.

2013. Washington reported very low levels of domoic acid with no closures.

Conclusion 2011–2013: Washington state consistently reported low levels of domoic acid for this period with no closures. A decade or so ago, harvesting closures due to ASP toxins occurred nearly every year.

DSP

2011. For the first time, DSP toxins were detected, causing four commercial closures in the Olympic Peninsula and Strait of Juan de Fuca. Sequim Bay experienced commercial and recreation closures due to DSP with 3 human illnesses reported. The highest DSP toxin level recorded was 160 µg per 100 grams of shellfish tissue.

2012. For the second year in a row, DSP toxins were detected resulting in closures at 20 sites. A closure at Ruby Beach, WA was the first ever on the Pacific coast due to DSP toxins.

2013. For the third year in a row, DSP toxins were detected resulting in closures at 11 recreational sites. The highest DSP toxin level recorded was 50 µg / 100 g shellfish.

Conclusion 2011–2013: Since the first toxicity and closures reported in 2011, DSP has become a serious and persistent problem for Washington state.

Alaska (Regions 25–27)

PSP

2011. Eight confirmed and 13 probable PSP cases in humans occurred in Alaska. This represents a considerable increase in the numbers reported in recent years (≤10 cases annually since 1998.) This was an active epidemiological investigation that uncovered poisoning cases that might not otherwise have been reported, indicating that the overall burden of PSP in Alaska likely is underestimated through standard reporting. However, saxitoxin levels were higher in shellfish that were tested during 2011 than in previous years, indicating that the increase in the number of cases might not have been entirely a surveillance artifact.

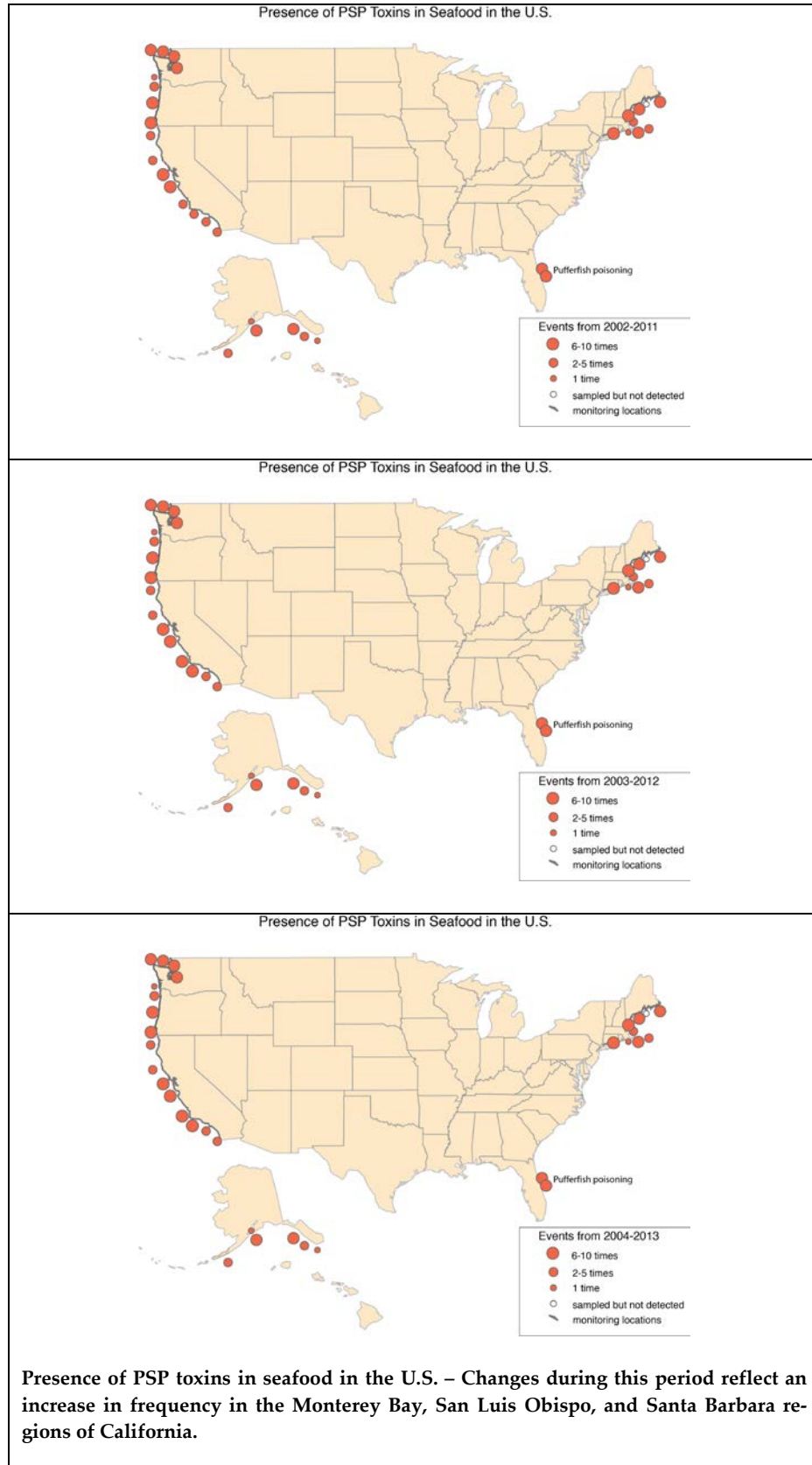
Alaska saw record high toxin scores – 30 000 µg STX per 100 g in baby mussels harvested from Rotary Beach in Ketchikan. Commercially harvested shellfish are tested for saxitoxin in Alaska are considered safe for human consumption, but shellfish collected by persons for their own use are not. Because shellfish harvesting is an important cultural tradition and shellfish are an important subsistence food source for many Alaska Natives and other Alaska residents, not everyone follows the public health recommendation to avoid eating shellfish from non-commercial sources. Furthermore, transient fish-processing workers in Alaska might be unaware of the potential danger of eating untested Alaskan shellfish because they are unfamiliar with PSP and might have limited English literacy.

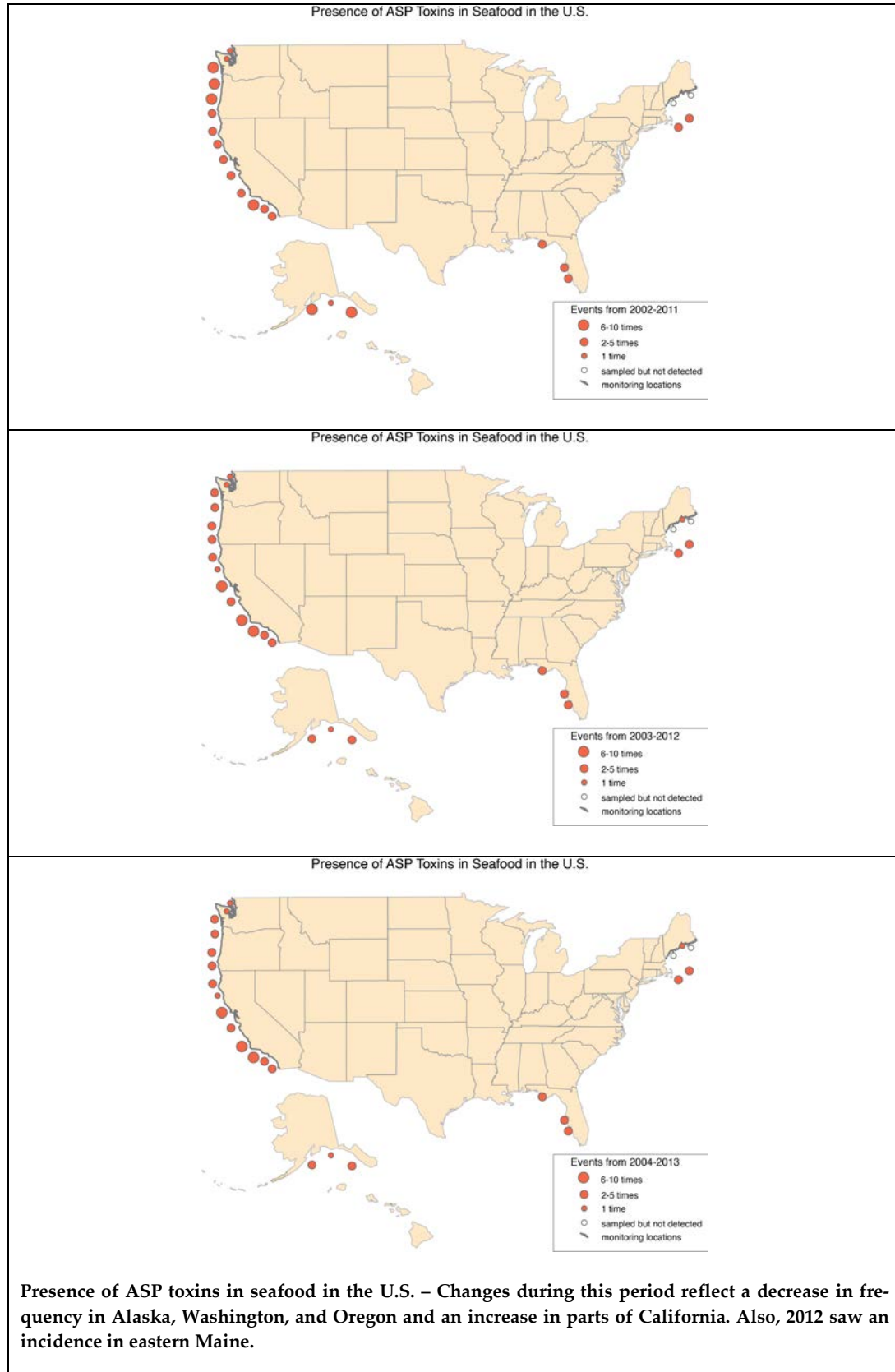
During the investigation, epidemiologists posted signs at beaches on Metlakatla and in the community to warn residents about the PSP risks associated with consuming non-commercially harvested shellfish. The warnings were printed in English, Tagalog, Russian, Spanish, and Korean. The Ketchikan Public Health Center and the Alaska Department of Fish and Game posted similar signs throughout Ketchikan and surrounding areas. Additionally, the Alaska Department of Health and Social Services issued press releases and conducted media interviews to inform the public about the outbreaks and the need to avoid noncommercial harvesting of shellfish.

2012. Three confirmed PSP cases occurred in Alaska. In all instances, shellfish were harvested from areas that were closed.

2013. Five confirmed human PSP cases occurred in Alaska. In all instances, shellfish were harvested from areas that were closed.

Conclusion 2011–2013: The number of human PSP cases in Alaska has risen during this period, possibly associated with the unusually high toxin scores. As noted, Alaska does not conduct routine monitoring except for commercially harvested shellfish. Therefore closed areas may be ignored by residents, thereby causing the possibility for exposure to toxicity.





Presence of NSP Toxins in Seafood in the U.S.



Presence of NSP Toxins in Seafood in the U.S.



Presence of NSP Toxins in Seafood in the U.S.



Presence of NSP toxins in seafood in the U.S. – Changes during this period reflect a decrease in frequency in Alabama and an increase in Texas.



5 Terms of reference C and D- HAEDAT and summarize HAB events

ToR C: Summarize the harmful algal bloom events 1990–1999 and in 2000 to 2009 in the ICES region based on decadal maps using HAEDAT with a view to investigating if data are of a quality that allows interdecadal comparisons

ToR D: Review progress regarding the entering of data onto the HAEDAT data-base and review synthesis stories (HAEDAT entries from start to date) submitted in advance from each country with a view of drafting a ‘synthesis story’ about HAB events in the ICES area.

Catherine Belin, France, made a presentation on the topic. A discussion followed.

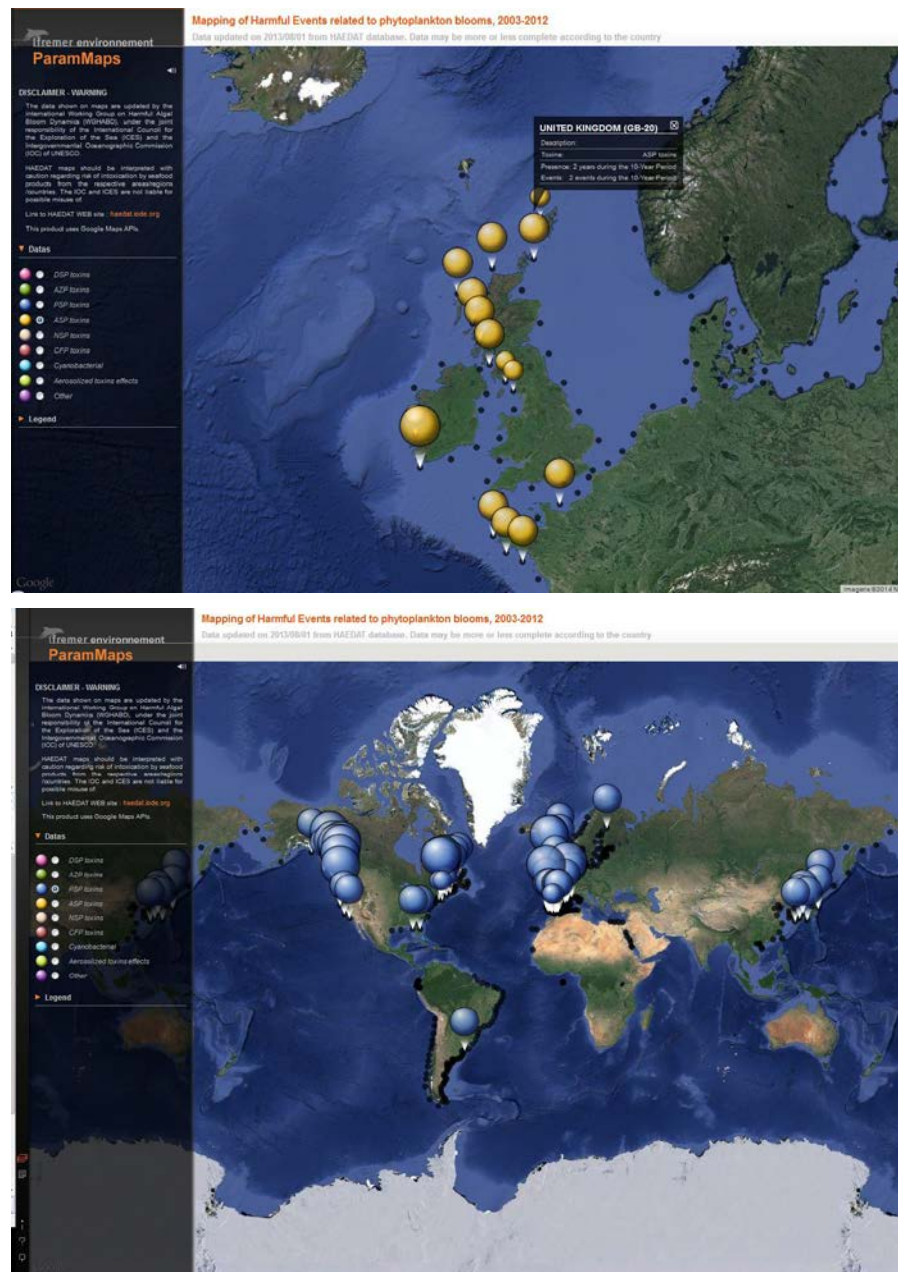


Figure: Examples of decadal maps based on HAEDAT.

6 Terms of reference E – automated observation systems

WG should report on Automated Harmful Algal Bloom in situ Observation Systems

6.1 Introduction

Automated plankton observation systems have been in development for the last decades. Currently some systems are becoming commercially available and may be used in studies of harmful algal bloom dynamics and as part of monitoring systems. There are at least three different approaches: 1) Imaging systems identifying, measuring and enumerating individual cells, 2) Systems based on molecular methods, basically in situ mini laboratories and 3) systems measuring bulk parameters such as the fluorescence of chlorophyll *a*. Harry Koos, an invited guest from the Dutch company CytoSense presented their imaging flow cytometer. Other brands include the Imaging Flow Cytobot (McLane Inc.) and the FlowCam (Fluid Imaging Technologies Inc.).

Three presentations were made on the topic of automated in situ observations systems. See also new findings (ToR a).

6.2 Autonomous HAB sampling systems – the ESP and the IFCB

Don Anderson

This presentation covered two new autonomous instruments that are being used in HAB monitoring and research – the Environmental Sample Processor (ESP) and the Imaging FlowCytobot (IFCB). The ESP (described in Scholin *et al.* 2009) is a submersible, robotic device that collects discrete water samples, concentrates microorganisms and other particles in the samples, extracts target molecules, and delivers processed extracts to assay modules. Real-time detection chemistries rely on DNA probes for cell detection (Greenfield *et al.*, 2008) and protein (antibody) arrays to detect target molecules such as HAB toxins (Doucette *et al.*, 2009), with data transmitted immediately to shore-based locations. The ESP represents a truly transformative technology with many potential applications, as evidenced in the two short videos at <http://www.mbari.org/esp/>. The ESP was developed at the Monterey Bay Aquarium Research Institute (MBARI) and is available commercially from McLane Research Laboratories Inc. (MRL), in Falmouth MA (USA).

The IFCB is a submersible imaging flow cytometer that uses a combination of flow cytometric and video technology to capture high resolution (1 μm) images of suspended particles (Olson and Sosik 2007). Extended unattended deployments (6–9 months) are possible because IFCB's automated operation includes antifouling procedures and periodic standard analysis to monitor instrument performance. Long term continuous plankton imaging by an IFCB deployed at Port Aransas, TX has already provided early warnings of six HAB events (Campbell *et al.* 2010; Campbell *et al.* 2013). This has been accomplished with a second-generation research prototype, which has now advanced to commercial production through license to MRL.

Currently, there are 10–15 ESPs being used worldwide, including six that are owned and operated by the developer, MBARI. Figure x shows the sites where ESPs are being used or deployed in 2014. Fewer IFCBs are in operation (perhaps 6 at this writing), but this number is expected to grow rapidly as more instruments are purchased from MRL.

Both of these are very powerful instruments with great potential to improve HAB monitoring and management. Both are also in the critical stage between development and operational use and sustained commercialization sometimes called the “valley of death”, meaning that strong demand by users and stakeholders is needed to motivate investments in modifications, improvements, and applications.

There are still many logistical and economic issues to be resolved with each. For the ESP, these include:

- 1) Cost and complexity of the instrument are both high, and preclude widespread use at this time.
- 2) A specialized mooring may be required for open-water deployments, and this is both expensive to purchase, and requires skilled personnel to deploy (D. Anderson, pers. comm.)/ Pier or dock-based deployments are much simpler.
- 3) Reagent costs are high, and currently can be purchased from a single supplier (Spyglass Technologies).
- 4) HAB detection arrays require species-specific information on the target species in a given region, and probe development and testing may be required.
- 5) Communication systems (between the ESP and shore) need to be set up for each application. Freewave and cell phone connectivity work well and are economical, but are restricted in range. Iridium (satellite) phone technology can be used, but ESP data images are large and thus phone charges can be prohibitive via Iridium.
- 6) Currently, for moored ESPs, deployment times are limited to 40 -45 days by battery capacity; also, only 44 samples can be processed for HAB species or toxin detection, again limiting deployment length. There are ways to circumvent both of these limitations, but development and retrofit costs are significant.



Dissemination and use of ESP Technology

Current (2014) collaborations:

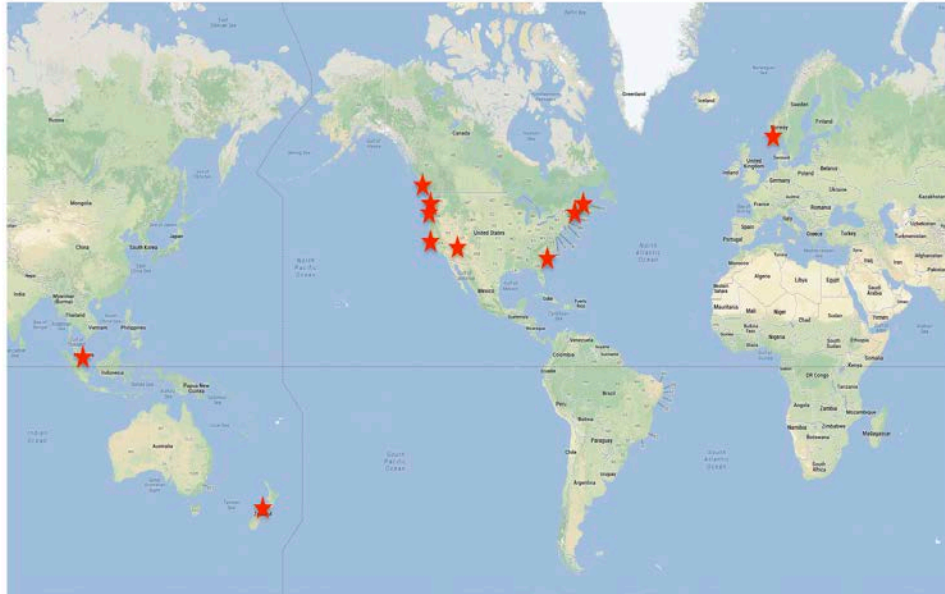


Figure: Locations where ESPs are being used in field or laboratory operations. Source: C. Scholin, MBARI.

For the IFCB, current constraints or issues include:

- 1) The IFCB generates millions of images during extended deployments, so automated analysis of images and data is needed (e.g., [Sosik and Olson 2007](#)). Current capabilities are strong and with time, more and more species will have classifier sets established for them, but new users will still need to build or test training sets and classifiers for the species that occur in their study area.
- 2) Power requirements of the IFCB are high, and autonomous, uncabled deployments have only been possible with generators, or the combination of generators and solar power, and then in nearshore waters, due to the need to provide gasoline or service at frequent intervals.
- 3) Discrimination of non-descript species (i. e, round, brown cells) is difficult; likewise, since some HAB species have toxic and non-toxic strains that can co-occur, the lack of toxin detection capability in the IFCB limits applications in those areas.
- 4) The lower limit of detection can be relatively high (1000 – 10 000 cells/L) as it is affected by the abundance of co-occurring organisms(i.e., a few cells of a target species are difficult to sample if they are vastly outnumbered by a dense bloom of another species), and by the limited sampling volume of the IFCB (currently 5 mls in 20 minutes). Automated classification can lead to large errors when the number of target cells is small.

Table 1 lists some of the features of the two instruments. This is not intended to be comprehensive, but rather to give a general impression of the costs, capabilities, and limitations of the two instruments.

Table 1. Comparison of ESP and IFCB costs, capabilities, and limitations.

Issues	ESP	IFCB
Cost of instrument	\$175 – 250K	\$125K
Pressure housing	\$30K	included
Reagent costs	\$3,000 – 4,000 for 45 days per ESP; HAB array costs additional	none
Mooring cost	\$125K	~\$10K for nearshore raft (no dedicated offshore mooring available yet)
Species discrimination	Highly specific	Discrimination of low abundance, non-descript species uncertain
Limit of detection	100 cells/L (4-L filtered)	1000 cells/L (5 mls/20 min)
Toxin detection	Yes	No
Number of samples per deployment	44 (Or 132 if samples are archived only and analyzed on shore)	16,000,000 - 36,000,000 (up to 6 months)
Power requirements	Batteries sufficient for 45-day deployments (WHOI mooring configuration); refinements underway to lengthen deployments to 4–5 months	Power needs still high – need generator, solar, or shore power
Mooring location	Open coastal waters, within cell phone range, unless Iridium funds are available	Nearshore waters only until power supply is improved (wind, solar, etc.).
Other constraints	Species-specific probes needed for each region	Training sets and species classifiers needed for each region

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6.3 Smart Observations of HABs by remotely piloted vehicles

Keith Davidson

The presentation considered three different approaches, two underwater and one airborne.

- 1) Autonomous underwater vehicles (AUVs)
- 2) Gliders
- 3) Remotely piloted aircraft (RPAs)

Initially the two underwater approaches were compared.

AUVs (despite the name) and gliders are automatic, mobile sensor platforms, akin to roving automatic weather stations. Every action is predicted (assuming no equipment failure).

Technical issues are power, navigation and keeping the sea outside.

Sensor development within carrying capacity of instruments is a major issue for HAB detection.

AUVs (figure 1) are relatively large vehicles (~3m long and 200 kg in weight) that are propeller driven. They have a relatively short duration of deployment, less than 24 hours.



Figure 1.

AUVs use acoustic navigation to survey an area.

AUVs typically communicate with the host laboratory using Iridium or wifi technology. They are excellent at surveying either in situ or using remote sensing, along a pre-determined route.

AUVs can be equipped with a range of different instrumentation. Typically this includes a CTD, but other instruments may include ADCP, microstructure sensors, fluorometers etc. AUVs typically have wet payload sections that are suitable for further instrument mounting.

Gliders (Figure 2) are buoyancy driven vehicles that can travel at slopes as gentle as 1:5 or as steep as 3:1. At gentle glide slopes the vehicle transits most efficiently, while steeper slopes are used to maintain position and act as a "virtual mooring."



Figure 2.

Gliders are smaller instruments (~2m long ~ 50 kg) and have much lower energy requirements than AUVs and hence are capable of much longer deployments, up to 6 months.

While gliders are capable of hosting similar instruments to a AUV, they do not have a payload capacity.

A review of the scientific literature identified a limited number of instances when AUV and glider technology had been used to study phytoplankton blooms using fluorescence signals, with a small sub set of these studies dealing with HAB events.

RPAs (Figure 3) include both directly controlled (piloted) and robotic aircraft. Compared to AUVs, Light RPA (<20kg) are technically simple and cheap. However, the operation of an RPA anywhere comes under regulation by international law as laid down by the International Civil Aviation Organization (ICAO). The challenges of operating RPA are legal, not technical.



Figure 3.

RPA's offer the potential to carry instruments capable of detecting water leaving irradiance and other optical parameters of the type surveyed by satellite. The use of an RPA offers the opportunity to survey at a much higher spatial resolution and/or when the weather is cloudy.

Post presentation the group discussed the relative merits of the different instruments.

The submerged instruments are potentially useful tools for HAB surveys, particularly in terms of their ability to survey below surface water that is inaccessible to satellite observation. They can therefore offer insight into the spatial and temporal evolution of blooms and provide early warning of blooms developing offshore.

RPA's offer the potential to carry instruments capable of detecting water leaving irradiance and other optical parameters of the type surveyed by satellite. The use of an RPA offers the opportunity to survey at a much higher spatial resolution and/or when the weather is cloudy.

The widespread use of these instruments was thought to be limited by the following factors:

- 1) Cost (for UAVs and gliders)
- 2) Skilled operators (all instruments)
- 3) A lack of suitable sensors

Of the above, criteria 1 and 2 are likely to decrease in importance with time as these instruments become more widely available.

A lack of suitable sensors (that must also be sufficiently small for deployment) is a major hurdle to be overcome this is likely only to be realised through pressure from the HAB community on instrument/sensor developers.

In the medium term, there is potential for these instruments to usefully survey high biomass HABs to provide early warning and a better understanding of the physical factors that govern their development, but low biomass biotoxin producing organisms remain a distant goal.

7 Terms of reference F – Review fish killing algae

Finalize draft a review document quantifying on the scale nature and extent of the problems associated with fish killing algae in the ICES region;

While not completed progress towards the completion of this term of reference has been made.

The ICES-IOC WGHABD was asked to address the issue of fish killing algae and identify research needs at its April 2012 meeting in Oban, Scotland.

The terms of reference for WGHABD were:

- Quantify the occurrence of fish killing algal events in the ICES area;
- Document gaps in understanding of the processes controlling the occurrence of fish killing algae and the factors that cause fish mortality.

The WG identified a need for a detailed assessment of the scale of the problem and the identification of key knowledge gaps.

WGHABD agreed the following actions:

- Forward the WGHABD summary to M Wells (PICES) to help inform discussion of fish killing microalgae at PICES; Completed.
- To prepare a report documenting the occurrence of fish killing algal events in the ICES area, gaps in understanding of the processes controlling the occurrence of fish killing algae and the factors that cause fish mortality; Ongoing.

The report will be based on a review of the literature that it is intended to submit as a peer reviewed scientific paper (potentially to the *ICES J Marine Science*).

An initial draft of this review has been prepared by R Gowen and K Davidson concentrating on the ecophysiology of the organisms and fish killing events in W. Europe.

An overview of progress was presented at the 2014 WGHABD. There was a desire to extend the coverage of the report to more fully cover the ICES area. To this end a number of other members of the group indicating a willingness to contribute to the paper/report (J. Martin -Canada, B. Karlson - Baltic, R Siano - France, A. Cembella - Toxins).

A provisional deadline of December 2014 was adopted for completion of the manuscript.

8 Terms of reference G – ICES ASC session on Harmful Algal Blooms

Review progress and advise the conveners on the planned session on Harmful Algal Blooms in Aquaculture and Fisheries ecosystems: prediction and societal effects at the 2014 ICES Annual Science Conference in La Coruna, Spain

The ICES-IOC Theme Session H on “Harmful Algal Blooms in Aquaculture and Fisheries ecosystems: prediction and societal effects” will be held during the ICES Annual Science Conference (A Coruña, Spain, 15–19 September 2014).

Conveners: Beatriz Reguera, Spain (beatriz.reguera@vi.ieo.es), Juan Blanco, Spain (juan.blanco@cimacoron.org) and Bengt Karlson, Sweden (bengt.karlson@smhi.se)

Conveners invited potential participants to contribute with oral/poster presentations on the following topics:

- Advances in the ecology and oceanography of HABs in the ICES domain
- Improvements in HAB forecasting – coupled physical-biological, and toxin uptake-detoxification models.
- HABs and their impact on wild fisheries and shellfisheries
- Emerging benthic HABs and their toxins.
- Advances in automated HAB observing systems, biosensors and toxin-detection methods.
- Mitigation strategies
- Supporting information for the end-users

Deadline for abstracts submission was 14th April 2014. There was an extension of this deadline until April 25 and by the time the WGHABD was held (28 April-2May) the convenors did not succeed to get a preliminary list of submitted abstracts. Nevertheless, after contacts with different contributors we know there are at least 20 submitted abstracts (from Spain, Portugal, France, Ireland, Germany and Sweden) which cover all the listed topics. Hopefully a fruitful session will derive from these presentations.

9 Terms of reference H – Symposium on HABs and climate change

Review progress and advice the scientific steering committee for the planned joint ICES–PICES–IOC scientific symposium on Climate change and harmful algal blooms. The symposium is planned to be arranged in 2015

Bengt Karlson, one of the conveners, presented the plans for the symposium. The further planning was discussed by the group.

Note written in August 2015. The symposium was arranged 19–22 May 2015 in Gothenburg, Sweden. More information is found at:

http://pices.int/meetings/international_symposia/2015/2015-HAB/scope.aspx

10 Terms of reference I – the Global Harmful Algal Bloom Status Report

Contribute to the development of a Global Harmful Algal Bloom Status Report

The UNESCO-IOC International Panel on Harmful Algal Blooms Different has started the development of a Global Harmful Algal Bloom Status Report. WGHABD is part of the process. Different ways of how to contribute to the report was discussed. This will be further addressed during next year's meeting.

Annex 1: List of participants

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Annex 2: Agenda

Tuesday, 29 April

Time	ToR	Lead(s)	Item
09:00–09:30		B. Karlson M. Poelmann	Opening of meeting, logistics, introductions, adoption of the agenda
09:30–10:00		B. Karlson	The new ICES Science plan and the three year reporting interval to ICES – what does it mean to the work of WGHABD?
10:00–10:30	i	All participants	WGHABD contribution to the development of a Global Harmful Algal Bloom Status Report This item will be revisited on Thursday
10:30–11:00			Health Break
11:00–11:30	f	R. Gowen	Finalize a review document quantifying on the scale nature and extent of the problems associated with fish killing algae in the ICES region;
11:30–12:00	g	B. Reguera	Review progress and advise the conveners on the planned session on Harmful Algal Blooms in Aquaculture and Fisheries ecosystems: prediction and societal effects at the 2014 ICES Annual Science Conference in La Coruna, Spain;
09:30–10:00	d	H. Enevoldsen	Review progress regarding the entering of data onto the HAEDAT data-base and review synthesis stories (HAEDAT entries from start to date) submitted in advance from each country with a view of drafting a ‘synthesis story’ about HAB events in the ICES area; This item will be revisited on Thursday
12:30–13:15			Lunch
13:15–15:00	b		National reports
15:00–15:30			Health Break
15:30–18:00	a		New findings/report writing
18:00			End of session

Wednesday, 30 April

Time	ToR	Lead	Item
09:00–10:30	e	D. Anderson	Session on Automated Harmful Algal Bloom in situ Observation Systems Presentations by WGHABD members and invited guests
10:30–11:00			Health Break
11:00–12:30			Continued
12:30–13:15			Lunch
13:15–15:00	b		National reports
15:00–15:30			Health Break
15:30–18:00	a		New findings/report writing
19:00–		Everyone	Group dinner (participant's expense)

Thursday, 1 May

Time	ToR	Lead	Item
09:00–10:30	c,d	All participants	Summarize the harmful algal bloom events 1990–1999 and in 2000 to 2009 in the ICES region based on decadal maps using HAEDAT with a view to investigating if data are of a quality that allows interdecadal comparisons; And: Review progress regarding the entering of data onto the HAEDAT database and review synthesis stories (HAEDAT entries from start to date) submitted in advance from each country with a view of drafting a 'synthesis story' about HAB events in the ICES area; Presentations for each country
10:30–11:00			Health Break
11:00–12:00			Continued

12:00–12:30		Persons interesting in hosting the WGHABD 2015 meeting	Presentations of possible venues for the 2015 meeting
12:30–13:15			Lunch
13:15–13:45	h	B. Karlson	Review progress and advice the scientific steering committee for the planned joint ICES-PICES-IOC scientific symposium on Climate change and harmful algal blooms. The symposium is planned to be arranged in 2015
13:45–14:15	i	B. Karlson and H. Enevoldsen	Revisit the WGHABD contribution to the development of a Global Harmful Algal Bloom Status Report
14:15–15:00		All participants	Draft 2015 Resolutions / ToRs for 2015–2017
15:00–15:30			Health Break
15:30–18:00		B. Karlson	Decide on 2015 Meeting Location Election of chair for the next three year period Draft 2015 Resolutions / ToRs for 2015 to 2017
18:00			End of meeting

Friday, 2 May

Time	ToR	Lead	Item
08:30–18:00		Marnix Poelman	Excursion

Excursion to get to know the Dutch shellfish sector. Mussel auction, mussel processing, oyster industry, Yerseke (mussel capital of North Europe), delta works. Bus transport will be arranged. Lunch, own expense.

Departure in the morning (8 or 9), return in Haarlem at 18.00 (subject to traffic jams).

Annex 3: WGHABD draft terms of reference for the next three year period

Working group meeting draft resolution for multi-annual ToRs (Category 2)

A **Working Group on Harmful Algal Bloom Dynamics** (WGHABD), chaired by Eileen Bresnan, UK, will meet in Lisbon, Portugal, 13–17 April 2015, to work on ToRs and generate deliverables as listed in the Table below.

WGHABD will report on the activities of 2015 by 15 June 2015 to SCICOM.

WGHABD-meetings to be arranged in 2016 and 2017 will be planned later.

ToR descriptors

ToR	DESCRIPTION	BACKGROUND	SCIENCE PLAN TOPICS ADDRESSED	DURATION	EXPECTED DELIVERABLES
a	Deliver National Reports on harmful algal events and bloom dynamics for the years 2014, 2015, 2016	HAB events may affect the human activities and marine ecosystems at different levels. Understanding can best be achieved by integrating multiyear data sets.	ICES Strategic Plan, Goal No. 1, and 2.	Year 1,2,3	Contribute with reports to HAEDAT
b	Finalise a review document quantifying the scale, nature and extent of the problems associated with fish killing algae in the ICES region	The WG identified a need for a detailed assessment of the scale of the problem and the identification of key knowledge gaps.	ICES Strategic Plan, Goal No. 1, and 2.	Year 1	Review paper
c	A one day Harmful Algal Event Data Workshop as part of the 2015 WGHABD Meeting (with intersessional work performed by delegates prior to WG meeting).	With participation from data base experts with experience in data input, export and analysis, formulating data for entry in HAEDAT, assist in bringing reports up to data and perform systematic QC of older data sets.	ICES Strategic Plan, Goal No. 1, and 2.	Year 1	Review of HAEDAT functionality; enhanced data set in HAEDAT; contribute to the development of a Global Harmful Algal Bloom Status Report by having standardized data analysis products. Summary of progress in Harmful Algal News.
d	Review the methodology used for the collection of	Sample collection is a critical component of monitoring	ICES Strategic Plan, Goal No. 1, and 2.	Year 1 and 2	Section in WGHABD report. Potentially also a

	<p>phytoplankton samples in harmful phytoplankton monitoring programmes and the abundances used as threshold levels in harmful phytoplankton monitoring programmes</p>	<p>programmes with methodology and factors such as water depth potentially regionally variable. There is a lack of information about how country to country differences vary in this approach or how methods vary from other standards (e.g. OSPAR ect). Many HAB monitoring programmes are designed to provide an early warning of HAB species and in some instances threshold levels (abundance of a particular species) are used to take further action. Threshold levels vary between region and in some instances were established historically. The use of threshold levels will be reviewed to establish if they are valid. This ToR will establish how homoegeous sampling methodology is in the ICES are and the usefulness and purpose of threshold levels.</p>			<p>review publication.</p>
e	<p>Report on new findings in the area of harmful algal bloom dynamics</p>	<p>WG members report new findings on the topic of algal bloom dynamics in the ICES area. This is a particularly valuable ToR for providing the most up-to-date status of HAB dynamics in the ICES area.</p>	<p>ICES Strategic Plan, Goal No. 1, and 2.</p>	<p>Year 1,2,3</p>	<p>A report on new findings in the area of harmful algal bloom dynamics.</p>
f	<p>Identify HAB datasets that could be used to investigate climate related changes in HAB species</p>	<p>Consult with Todd O'Brien (NOAA) about the feasibility of using WGZE/WGPME time series analysis</p>	<p>ICES Strategic Plan, Goal No. 1, and 2.</p>	<p>Year 1, 2</p>	<p>An ICES Harmful Algal and/or Toxin status report; contribute to the development of a</p>

	phenology; present the assessment of representative datasets to describe HAB initiation and temporal trends and spatial variability; review outputs using the standard WGZE and WGPME result formatting.	techniques to analyse identified harmful phytoplankton and/or toxin time series data available from WGHABD and identify editorial team (Year 1) to produce a Harmful Algal and Toxin Status CRR (Year 32).			Global Harmful Algal Bloom Status Report.
g	Evaluate use of harmful/nuisance algae as an indicator of 'Good Ecological Status' for the Marine Strategy Framework Directive Descriptor 5 (Eutrophication). Review draft OSPAR JAMP Eutrophication Guidelines on phytoplankton species composition.	Descriptor 5 of the MSFD lists 'bloom events of nuisance/toxic algal blooms (e.g. cyanobacteria) caused by human activities' as a direct effect of nutrient enrichment. The use of nuisance/toxic algae as indicators for this descriptor will be reviewed. ICES is requested to advise OSPAR on the revision of the OSPAR JAMP Eutrophication Guidelines. Since these guidelines were developed there has been considerable work done on the response of the phytoplankton community to environmental and anthropogenic drivers. The use of the JAMP guidelines will be reviewed.	ICES Strategic Plan, Goal No. 1, and 2.	Year 1 and 2	Potentially a comment paper for ICES Journal.
h	Review progress and advice the scientific steering committee for the planned joint ICES-PICES-IOC scientific symposium on Climate change and harmful algal blooms. The symposium is planned to be arranged in 2015	Climate change will affect the distribution of HAB species and the development of HAB. An ICES-PICES-IOC scientific symposium on climate change and harmful algal blooms is planned to be arranged in Gothenburg, Sweden	ICES Strategic Plan, Goal No. 1, and 2.	Year 1	Advice to the Organizing Committee.

18–22 May 2015.					
i	Review progress in development and application of molecular genetic technologies for taxonomic identification, phylogenetic reconstruction, biodiversity, toxin detection and population dynamic studies of HABs.	Molecular technologies are developing at a rapid pace. These new methods have the potential to deliver key information about the diversity and toxicity of HABs and revolutionise how monitoring is performed. Many methods are being developed in isolation with little standardisation between protocols or integration in monitoring programmes which have the capacity to exploit their potential.	ICES Strategic Plan, Goal No. 1, and 2.	Year 1, 2, and 3	a) A review of progress in development of new methods for HAB species dynamics (Year 1) b) Common sampling and methodological protocols for application to field studies (Year 2) c) Contribute to a workshop on validation and comparison of alternative technologies (Year 3) d) A review of advances in new technologies for research and monitoring applications (Year 3)
j	Review the existing knowledge and latest findings on BMAA, the amino compound β-methylamino alanine	Although the the research into BMAA has been conducted for more than decade, there is still some controversy regarding the status of this toxin. Recently, new data on BMAA producers among phytoplankton organisms and on its toxicity have been published. They shed new light on the real threat related to BMAA presence in sea food and methodologies on how to accurately measure this toxin.	ICES Strategic Plan, Goal No. 1, and 2.	1	Part of WGHABD report
l	Review how physical and biological interactions control the dynamics of relevant harmful micro-algal blooms	Harmful algal genera respond to environmental forcing in different ways. in each year a different genus will be	ICES Strategic Plan, Goal No. 1, and 2.	Year 1,2 and 3	Review papers on physical and biological interactions control the dynamics od

evaluated to provide a comparative evaluation of known and potential responses to physical / environmental forcing.	selected genera of HAB. Year 1 will focus on <i>Gymnodinium</i> . Species for subsequent years will be decided by the WG. Each review will result in a 'review' paper for the ICES journal.
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Summary of the Work Plan

Year 1 Review of OSPAR and MSFD D5 Eutrophication guidelines, review of fish killing algae, Updating and quality control of data in HAEDAT, symposium on climate change and HABs. Identify data sets and editorial team for the HAB status report. , current status of BMAA. Review on Hab genus *Gymnodinium*.

Year 2 Completion of HAB status report, review of sampling methodologies and threshold levels in monitoring programmes, plan workshop on molecular techniques, Contribute towards Global HAB report as required. Contribute towards MSFD as required. Review on HAB genera tbc. ToR to be decided,

Year 3 Contribute to a workshop on new/molecular genetic techniques, Review of new technologies, Review on Hab genera tbc. Contribute towards Global HAB report as required. Contribute towards MSFD as required. ToR to be decided

Year 1–3 Work on Global HAB report , update the Harmful Algal Event Database, report new findings, physical-biological interactions – selected HAB genera

Supporting information

Priority	The current activities of this Group will lead ICES into issues related to the ecosystem effects of fisheries, especially with regard to the application of the Precautionary Approach. Consequently, these activities are considered to have a very high priority. Work performed will also address to ICES action areas on Aquaculture and MSFD. ICES Pillars 1 – 3 and Goals 1 – 3.
Resource requirements	The research and monitoring programmes which provide the main input to this group are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants	The Group is normally attended by some 20–25 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	There are no obvious direct linkages.
Linkages to other committees or groups	There are working relationship with WGPME, WGZE and WGPBI. The cooperation with WGAQUA and WGIMT could be further developed.
Linkages to other organizations	UNESCO-IOC Intergovernmental Panel on Harmful Algal Blooms, IOC/SCOR Global HAB (previously GEOHAB -Global Ecology and Oceanography of Harmful Algal Blooms)

Annex 4: Group photo 2014



Left to right: Bengt Karlson, Don Anderson, Milligan Stephen, Henrik Enevoldsen, Keith Davidson, Eileen Bresnan, Ainhoa Blanco, Beatriz Reguera, Allan Cembella, Jennifer Martin, Raffaele Siano, Margarita Fernández Tejedor, Catherine Belin, Hanna Mazur-Marzec and Marnix Poelmann.